

REPORT
OF THE
DEPARTMENT OF MINES
FOR THE
FISCAL YEAR ENDING MARCH 31, 1922

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OTTAWA
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*To His Excellency Baron Byng of Vimy, G.C.B., G.C.M.G. M.V.O., Governor
General and Commander in Chief of the Dominion of Canada.*

MAY IT PLEASE YOUR EXCELLENCY:

The undersigned has the honour to lay before Your Excellency, in compliance with 6-7 Edward VII, chapter 29, section 18, the report of the work of the Department of Mines, for the fiscal year ending March 31, 1922.

CHARLES STEWART,
Minister of Mines.

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REPORT

OF THE

DEPARTMENT OF MINES

FOR THE FISCAL YEAR ENDING MARCH 31, 1922

Honourable CHARLES STEWART,
Minister of Mines,
Ottawa.

SIR,—I have the honour to submit the Annual Report of the Department of Mines for the year ending March 31, 1922.

Details of the operations of the various branches of the Department are contained in the reports which follow of the heads of these branches. These reports deal with changes of staff, and classification, the activities of individual officers and divisions, and the more important results that have been obtained both in field and laboratory investigations. It is necessary, however, to refer here to an event which had an important bearing upon the personnel and work of the Department, namely, the reclassification. This was applied to the Department in 1919 and caused widespread dissatisfaction resulting in the resignation of a large proportion of the technical staff. It is satisfactory to record that a readjustment of the classification was approved by Council in October, 1921, but owing to the change of Government was not applied until May, 1922. The application of the new schedule of technical salaries has allayed to a considerable extent the unrest that existed, and this, combined with the depressed condition of the mining industry and the consequent lack of outside positions, is responsible for the fact that there have been no resignations of technical men during the past year.

It is, however, not to be expected that the present condition of quietude will be maintained, for it is still evident that by comparison with geological or mining departments of other countries and even universities, the Canadian scale of technical salaries is low and will be insufficient to retain the services of our best men when mining conditions throughout the country improve.

Although referred to in the report of the Director of the Victoria Memorial Museum, attention is here called to the excellent work, instituted by the Museum staff, of conducting a course throughout the winter of weekly illustrated lectures on the natural resources of Canada. In this the services of the Geological Survey staff have been enlisted, and moving pictures have been generously provided by the Department of Trade and Commerce. The course consists of a series of lectures for children on Saturday mornings and for adults on Wednesday nights. The response, particularly on the part of the children, has been excellent and most gratifying to the lecturers and committee in charge.

The expansion of the mining industry of Canada will necessitate increased appropriation and staff in order to meet the additional demands that are being made upon the Department as a result of that expansion, and in order to meet and solve the problems in fuel and mining technology that are constantly arising. The housing

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of the Geological Survey staff and the staff and exhibits of the Museum under one roof has had a detrimental effect on the work and growth of the Museum, and the Museum can never fulfil its proper function as a National Museum until arrangements are made whereby a much greater proportion of the building is devoted to exhibition purposes. In fact the whole question of housing for the staff and laboratories of the Department is becoming more acute and will have to be considered in the near future.

The Peat Committee continued its work at Alfred, Ontario, in developing and trying out machinery for the making of air-dried peat fuel. The efforts of the committee were concentrated on one machine, for which a new conveying and spreading device was tried out. This was found to be entirely satisfactory though it was not possible to give it a full season's trial. Altogether some 5,000 tons of peat fuel were made, most of which was sold in the city of Ottawa. The work of the committee, though as yet incomplete, has shown that a very satisfactory fuel can be made from peat and that a very large demand can be created and in fact now exists for such fuel if it can be supplied at a reasonable rate.

The annual report for 1920 referred to the depressed condition of the mining industry generally, and it is satisfactory to record that there has been a distinct improvement in this industry during the latter part of 1921. A large proportion of the capital invested in the mining industry in Canada is supplied by the United States, and at the present time our principal foreign market for our non-metallic products is in that country. Unfortunately the proposed revision of the tariff in that country will make it more difficult for Canada to supply that market and it will be necessary to seek other markets for the products affected by the revision, which are mainly non-metallic products. It is possible that such markets may be obtained in Europe and especially Great Britain and it is the intention of the Department to go thoroughly into this question.

The question of British markets for our mineral products is being taken up with the Imperial Mineral Resources Bureau in London and it is hoped that this organization will be so developed as to act as an intermediary between the Canadian producer of minerals and the British consumer. Dr. W. G. Miller is the Canadian Governor on the Bureau, but owing to his inability to leave Canada last spring his place on the Board of Governors was temporarily taken by Dr. H. M. Ami, who rendered valuable service in this capacity.

Your obedient servant,

CHARLES CAMSELL,

Deputy Minister.

GEOLOGICAL SURVEY

W. H. Collins, Director

ORGANIZATION

A tabular statement of the organization of the Geological Survey was made in the Annual Report for the year ending March 31, 1921. This organization has been augmented by a Map Engraving Division, consisting of four copper-plate map engravers. Formerly, the engraving of maps for all departments was done in the Department of Public Printing and Stationery, but in December, 1921, it was decided to distribute the staff of engravers among the chief map-making departments; four were allotted to the Geological Survey. Under the present arrangement these four engravers, though still employed by the Department of Public Printing and Stationery, are quartered with the Geological Survey, and operate as part of its staff. This arrangement, permitting closer co-operation between draughtsmen and engravers, will reduce the amount of draughting and has already increased the production of engraved work and effected a saving in cost of nearly 50 per cent.

During the year the Civil Service Commission working in conjunction with the Department of Mines, has almost completed the reclassification of the employees of the Geological Survey and the revision of the scale of salaries. Although this reclassification has not been satisfactory in every respect as evidenced by the resignations, it has on the whole greatly improved conditions in the Survey. Since October 1, 1920, thirteen employees have been converted from a temporary to a permanent status, giving them an added security of position and the advantage of regular increases of salary. There has been some increase in the salary range of about half of the classes represented, and in a majority of these cases the adjustment of salary was made retroactive to April 1, 1919, or 1920, in order to compensate for delay in reclassification. The various classes of employees have been established on a more equitable footing, from which basis, as living conditions approach equilibrium, it should be easier to make further revisions.

CO-ORDINATION OF SURVEYS

Surveys for the preparation of contoured topographical maps are made by the Geological Survey, the Department of National Defence, and by the Department of the Interior. These organizations have conducted survey work for different immediate purposes, mainly in different areas, so there has been little or no overlapping or duplication work. There has not been, however, as close conformity in respect to standards of accuracy, scales of compilation and publication and other essential factors, as is requisite to make the results of these different organizations part of a uniform scheme of topographical mapping of Canada, comparable with the systems in effect in most other countries. On March 8, 1922, a Board of Topographical Surveys and Maps was created (P.C. 540), to effect this desired end, and it may now be hoped that, in future, the energies of the various topographic mapping organizations will be co-ordinated, economies effected, and more direct progress made in the systematic mapping of the country. The board consists of two representatives from each of the three departments concerned, the Geological Survey being represented by the Director, and the Chief of the Topographic Division.

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FIELD OPERATIONS

The Geological Survey had forty-three parties operating in various parts of Canada during the summer season of 1921. Ten of these were engaged in making surveys for topographical maps which will be required as base maps for investigations of the geology, and mineral deposits. These topographical maps are also constructed to serve other practical purposes—highway construction, forestry, land settlement, etc.—and as unit contributions to the systematic mapping of Canada. The other thirty-three parties were engaged in geological work of various types. Nineteen were mapping mineralized districts or investigating the mode of origin, extent, and value of ore deposits. Five were engaged in the systematic geological mapping of the country, which is fundamental to more directly economic investigations. One was collecting fossil specimens for the Victoria Memorial Museum. One was collecting, for the Department of Justice, geological evidence relative to the Canada-Newfoundland boundary line parallel with the Labrador coast. Six carried on exploratory work in northern Canada.

The exploration of northern Canada is a special function of the Geological Survey. Over half of Canada, climatically, geographically, or topographically, is unsuited for agriculture, and the highly organized settlement possible only in agricultural regions. Yukon, the great Hudson Bay and Mackenzie River regions, and much of British Columbia have been explored and developed for their furs, their fish, and above all, for their mineral wealth. Between this great northern region, which is never likely to sustain a highly organized civilization, and the agricultural and industrial part of Canada, lies an intermediate zone which will in time become permanently settled, but in which the farmer must be preceded and beckoned by the lumberman, the prospector and miner, and the railway builder. The northern parts of Ontario and Manitoba, containing the Porcupine gold district, the Cobalt silver district, the Sudbury nickel-copper district, and the Mandy and Flin Flon mines, are parts of this zone which owe their industrial development initially to their mineral wealth. It has, therefore, been the inalienable and important function of the Geological Survey of Canada, since its foundation in 1842, as the scientific assistant to the prospector in his search for mineral wealth, to accompany him in his pioneer work and to be the chief Government organization engaged in the exploration of the vast unagricultural parts of Canada.

Between 1915 and 1920, when the internal energy of the country was turned to production rather than to new developments, Geological Survey field operations became largely restricted to problems of mineral production in districts within operating reach of transportation. Exploration work was almost suspended. Now, with a return to normal conditions, public attention is being directed once more to the search for mineral deposits, and the Geological Survey is also resuming exploration work. In 1921 a systematic exploration was begun of the petroleum-bearing region in the Mackenzie River basin. An expedition, also, was sent to investigate the commercial possibilities of vast deposits of iron formation on Belcher islands, Hudson bay, which, because of their accessibility by ocean-going vessels, are attracting much attention.

The geological field work done during the summer is itemized more fully below.

GEOLOGICAL FIELD WORK

W. E. Cockfield made detailed topographical and geological maps of three small areas (Stand-to hill, Rambler hill, and mount Cameron) in the vicinity of Mayo, Yukon Territory. These areas are mineralized with veins carrying silver-lead ores similar in origin to the rich silver-lead mines at Mayo, and constitute outlying parts

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of one mineral district. A full report of Mr. Cockfield's work, illustrated with three geological maps, appears in the Summary Report of the Geological Survey, Part A.

F. H. McLearn made a detailed examination of the geological succession and fossil fauna of an area of 60 square miles surrounding Skidegate inlet, Queen Charlotte islands. This area contains a typical and fossiliferous succession of Cretaceous and Early Tertiary formations and should, as studied by Mr. McLearn, furnish a key or reference area for the geological mapping of the Cretaceous formations elsewhere along the Pacific coast. The principal coal deposits of British Columbia are contained in the Cretaceous, and a knowledge of its stratigraphy is, therefore, of practical importance.

George Hanson mapped geologically, on a scale of 1 inch to 1 mile, an area of 50 square miles situated on the upper part of Kitsault¹ river, Portland Canal district, B.C. This area lies along the eastern side of the Coast batholith and is part of the great mineral belt that fringes the batholith. The Kitsault area contains quartz veins carrying values in silver. A full account of these ore deposits, with a geological map of the area, is given in the Summary Report, Part A.

Victor Dolmage continued an exploration of the west side of the Coast batholith, which, like the eastern margin, is a great zone of mineralization. This western edge coincides approximately with the highly indented Pacific coast of British Columbia, a circumstance which renders any mineral discovery easy of access. Mr. Dolmage's work in 1921 consisted of a geological exploration of the coast-line and islands from Burke channel northward to Douglas channel. A report upon the geology, mineral deposits, and hot springs of this section, with a preliminary geological map, appears in the Summary Report, Part A.

J. D. McKenzie commenced a detailed examination and mapping of the Cretaceous coal basin on the east side of Vancouver island, in the vicinity of Comox and Nanaimo. Operating collieries find difficulty, owing to the complicated structure of the coal measures, in correlating the result of their exploratory drilling and in planning underground operations. Mr. McKenzie is endeavouring to relieve this difficulty by working out the underground structure of the basin. The investigation, which will extend over two or three years, is also part of a systematic investigation by the Geological Survey of the coal resources of Canada. Mr. McKenzie's work included examination of some copper deposits on Laqueti island, a report upon which is included in the Summary Report, Part A.

C. E. Cairnes completed the geological mapping and examination of ore deposits of Coquihalla map-area, on the Kettle Valley railway just west of Hope. This area of 300 square miles contains deposits of gold, silver, copper, molybdenum, and manganese ores. A full report, accompanied by a geological map of the area on a scale of 1 inch to 1 mile, has been prepared and will be published as a Geological Survey memoir.

W. L. Uglov commenced the geological mapping on a scale of 1 inch to 1 mile of a belt of country about 10 miles on either side of the Canadian National Railway line which runs north from Kamloops to Prince George. The area completed this year in the general vicinity of Cha Chau contains coal, gold in veins and in placers, and silver-lead-zinc ore; reported platinum-bearing pyrite deposits were found not to contain this metal. A full report of Mr. Uglov's work, with a geological map, appears in the Summary Report, Part A.

W. A. Johnston commenced a study of the gold placers of Barkerville area, Carleton district. These placers are of Tertiary age and, since their formation, the country has been glaciated, covered with a mantle of drift, and the drainage has been modified. As a result the placer deposits do not coincide in all cases with the modern stream channels. Mr. Johnston is endeavouring to work out the preglacial

¹ Since Part A, Sum. Rept., was published, the Geographic Board have changed this name from Kitzault to Kitsault.

drainage, and distribution of the placers. A preliminary report, accompanied by detail maps of parts of Antler and Williams creeks, appears in the Summary Report, Part A.

Mr. Johnston also worked out the areal geological mapping of an area in the vicinity of Vancouver, and made an examination, of scientific interest, of the sediments which are being deposited from glaciers in lake Louise, at Banff.

M. F. Bancroft continued the geological mapping of Lardeau area, south of Revelstoke. The area contains deposits of silver-lead-zinc ore, talc, manganese carbonate, and Iceland spar. A short review of his results is given in the Summary Report, Part A.

S. J. Schofield commenced the geological mapping of the Windermere map-area, situated on the railway line between Cranbrook and Golden. Preliminary to this, the geological formations were traced from near Cranbrook, where earlier geological work had been done, so that the formations in Windermere area could be properly correlated with those at Cranbrook. It is hoped that a continuation of the work Dr. Schofield is doing will eventually permit of correlating other isolated pieces of geological work and of combining these in one general geological map of south-eastern British Columbia.

J. R. Marshall commenced the geological mapping of the Kananaskis map-area, situated on the western boundary of Alberta between latitude $50^{\circ} 30'$ and 51° . This area contains important and extensive bituminous coal deposits within 45 miles of a railway. Mr. Marshall's work also is contributory to a systematic inventory of the coal resources of Canada. A summary of the work accomplished appears in the Summary Report, Part B.

D. B. Dowling, G. S. Hume, M. Y. Williams, and E. J. Whittaker commenced a systematic geographical and geological exploration of the Mackenzie River region, more particularly to ascertain the possibilities in this region of petroleum, natural gas, and other mineral deposits characteristic of stratified formations. Besides working out the stratigraphy and structure of the rock formations surveys are being made of all navigable waterways tributary to the Mackenzie so that reliable base maps can be compiled. A good survey of the Mackenzie was being made by the Topographical Surveys Branch of the Department of the Interior.

Mr. Dowling examined the country in the general vicinity of Norman, where a well yielding petroleum was drilled in August, 1920. Mr. Hume explored and mapped the country on the west side of Mackenzie river from Simpson northward to Wrigley. Mr. Williams performed similar work on the east side of the river. Mr. Whittaker explored on both sides of the river from Great Slave lake downstream to Simpson. Reports by all four geologists, accompanied by geological maps, appear in the Summary Report, Part B. A report upon the country south of Great Slave lake, by A. E. Cameron, is also included. Owing to the immense extent of the region this work will probably be continued for several years.

C. M. Sternberg collected fossil dinosaur and other vertebrate remains from near Red Deer, southern Alberta. A collection of fossil fishes was also made near Banff.

H. C. Cooke made a detailed investigation of the nickel-copper ore deposits at Oiseau river and Maskwa river, and of the gold ore deposits of Rice Lake district, all in Manitoba, east of lake Winnipeg. Mr. Cooke succeeded in ascertaining the mode of origin and the geological relationships of both these classes of ore deposits and indicated on what lines future prospecting work should be conducted. A full report upon his work with geological maps of the mineralized areas, constitutes Part C of the Summary Report.

T. L. Tanton continued geological mapping of an area of about 2,500 square miles in the vicinity of Port Arthur and Fort William. The area contains deposits of silver-lead, zinc, copper, and iron ores. Mr. Tanton's work is designed to assist

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in the prospecting for these minerals by ascertaining their origin and geological relationships and supplying a reliable map of the various rock formations. Part of his results are described in Part D of the Summary Report.

Aleph Anrep made detailed surveys of three peat bogs near Fort William and Port Arthur and one near Verona, in Addington and Frontenac county, Ontario. This work is contributory to a systematic inventory of the peat fuel resources of Canada. A full report of the year's work, accompanied by plans of each bog, appears in the Summary Report, Part D.

Ellis Thomson continued the geological mapping on a scale of 1 inch to 1 mile of an area of 430 square miles near Missinaibi, Michipicoten district, Ontario. This area contains productive deposits of pyrite, and during the year a very promising discovery of gold was made on what are known as the Murphy claims. A preliminary report upon the Murphy and other gold discoveries is included in the Summary Report, Part D.

Sir Stopford Brunton mapped an area of 144 square miles on the Algoma Central railway 20 miles north of Sault Ste. Marie. This work was done in connexion with an investigation of various occurrences of iron ore which lie within the area. A full report accompanied by a geological map on a scale of 1 inch to 1 mile appears in the Summary Report, Part D.

J. F. Wright explored and mapped a Precambrian area lying south of Biskotasi, Ontario, on the main line of the Canadian Pacific railway. He also examined a reported discovery of iron ore 30 miles north of Blind River which proved to be of insignificant size.

T. T. Quirke mapped an area of about 200 square miles surrounding lake Wanapitei, near Sudbury. Mr. Quirke's work is in continuation of a programme of correlation of the Precambrian (chiefly Huronian) formations of northeastern Ontario which has been under way since 1914 and is now culminating in the production of a general geological map of northeastern Ontario. Mr. Quirke's work has done much to simplify and elucidate the complex geology of this extraordinarily mineralized region. A full report of his work during 1921, accompanied by a geological map on a scale of 1 inch to 1 mile, appears in the Summary Report, Part D.

H. V. Ellsworth commenced a systematic investigation of the rare-element minerals of Canada. These rare elements, including uranium, thorium, radium, cerium, beryllium, etc., are being applied in the arts and industries in many new and important ways and the demand for them is growing rapidly. In Canada, these minerals occur chiefly, so far as yet known, in the "Grenville" region of eastern Ontario and Quebec and Mr. Ellsworth's work was accordingly commenced in the district between Ottawa and Parry Sound, in which a number of discoveries of radioactive minerals have been made in recent years. A preliminary report of his results is given in the Summary Report, Part D.

M. E. Wilson continued geological mapping of an area of Precambrian formations near Madoc, Ontario. This area is one of a series of key areas which Mr. Wilson is extending across the "Grenville" subprovince of the Precambrian shield for correlational purposes. The Madoc area contains deposits of fluorspar, talc, pyrite, and other minerals and during 1921 attention was given particularly to the talc deposits as part of a systematic inventory of the talc resources of Canada.

Robert Harvie completed the geological mapping, on a scale of 4,000 feet to 1 inch, of an area of 210 square miles in the vicinity of Thetford and Black lake, Quebec. The area is part of the "Serpentine belt" and contains some of the most important asbestos mines in southern Quebec.

Eugene Poitevin investigated the minerals associated with the asbestos deposits near Black Lake, Quebec. This detailed investigation, covering 200 square miles, has thrown some light on the origin of chrysotile asbestos deposits.

F. J. Alcock made a topographical and geological survey of an area of 70 square miles in the vicinity of the Federal Zinc and Lead mine, Gaspé peninsula. This

area contains deposits of lead-zinc and copper ores, and is deserving of being prospected further. Two weeks were spent in examining geological sections on York river and the adjacent coast, in which vicinity a small amount of petroleum has been obtained by drilling wells. A full report of Mr. Alcock's work, including an account of the Federal Zinc and Lead mine, and illustrated with two geological maps, appears in the **Summary Report, Part D.**

G. A. Young visited Belcher islands, in Hudson bay, to investigate the value as iron ore of the iron formation which underlies a large part of the islands. The deposits are of enormous extent and are directly accessible by ocean-going vessels. Various examinations have been made during the last ten years for different private parties, but the resultant reports differed essentially regarding the commercial value of the deposits. An impartial official opinion seemed to be desirable either to confirm other favourable reports or to contradict them and so discourage further useless expenditure. The Belcher islands iron formation is of further interest in that huge areas of similar formation occur in the interior of New Quebec and, in the event of a favourable report upon the Belcher Islands occurrence, these other less accessible areas would become of enhanced interest. A full report of Mr. Young's results is comprised in **Part E of the Summary Report.**

W. S. McCann completed the geological mapping of an area near Moncton and the investigation of the oil-shale deposits which occur there. This work had been commenced by Mr. W. J. Wright, who resigned from the Geological Survey before the undertaking was finished. A memoir upon the area and the oil-shale deposits, accompanied by geological maps, is now in course of publication.

E. R. Faribault continued systematic geological and geographical mapping on a scale of 1 inch to 1 mile, of the Middleton and Paradise map-areas in northwestern Nova Scotia. A detailed examination was begun of the Nictaux and Torbrook iron ranges which occur in the area mapped. These ranges have yielded about 500,000 tons of iron ore and are still of economic interest.

W. A. Bell completed the areal and structural geological mapping of an area near Sydney, Nova Scotia, which contains important coal deposits. Geological work was commenced some years before by Mr. A. O. Hayes, who, however, resigned from the Survey before bringing the work entirely to a conclusion. A memoir embodying the combined results of the work of Mr. Hayes and Mr. Bell, accompanied by a geological map on a scale of 1 inch to 1 mile, has been completed and is in course of publication.

E. M. Kindle made, on behalf of the Department of Justice, an investigation at lake Melville of the geological and biological evidence bearing upon the question of the boundary between Canada and Labrador, belonging to Newfoundland. A full report on Mr. Kindle's results has been supplied to the Department of Justice.

TOPOGRAPHICAL DIVISION

W. H. Boyd, Chief Topographer, reports as follows:

The officers of the Topographical Division carried on field work from May until October, and during the remainder of the year were engaged in compiling and drawing the original manuscript maps of the areas surveyed.

The division includes two sections: one small section consists of two geodetic engineers who are wholly engaged in carrying out the necessary main control for the topographical mapping. This section is too small to fill all the demands of the work; consequently, in many cases the topographical parties have to execute their own main control; this necessarily results in a decrease of the amount of mapping accomplished. More geodetic engineers are required to fill the needs. In the control work carried on by the geodetic engineers, close co-operation is maintained with the Geodetic Survey of Canada. The control triangulation is executed with sufficient refinement

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to be used as the secondary control system between the primary stations of the Geodetic Surveys. The other section consists of eight topographical engineers who are responsible for the actual map work.

Although the division is small, a great amount of work is accomplished. Some engineering clerks are needed to assist both sections in the office work. It is, at present, difficult for the division to keep up with the demands of the work, and, in some cases, altogether impossible.

MAIN CONTROL FOR TOPOGRAPHICAL MAPPING

S. C. McLean was engaged in carrying on triangulation in Quebec and New Brunswick. In Quebec, the control was for the mapping in the vicinity of Broughton. In New Brunswick, for the mapping in the vicinity of Moncton, and for projected mapping in the district. Both triangulation systems are based on primary stations established by the Geodetic Survey of Canada in the respective neighbourhoods.

R. C. McDonald carried out the triangulation southeastward from Mountain park, Alberta. This is for the control of the mapping in that vicinity and for future topographical requirements.

TOPOGRAPHICAL MAPPING

A. C. T. Sheppard commenced mapping an area in the vicinity of Comox and Cumberland on the east side of Vancouver island. About 100 square miles was completed. The scale is 1 mile to 1 inch with a contour interval of 50 feet. The mapping in this district is hindered by the heavy timber and lack of roads or trails inland.

D. A. Nichols mapped a section of country along the Canadian National railway from Fishtrap creek on North Thompson river down to and including Kamloops, B.C. This is a continuation of the mapping of the North Thompson valley begun by Mr. Nichols in 1918. The area completed this season covers about 280 square miles. The scale is 1 mile to 1 inch with a contour interval of 100 feet. North Thompson valley from Clearwater river to Kamloops is now completely mapped.

R. Bartlett mapped 250 square miles in Kootenay valley on the scale of 1 mile to 1 inch with 100-foot contour interval. This area extends from the International Boundary, 49th parallel, northward along the Kootenay valley, B.C.

W. H. Miller commenced mapping near Mountain park, Alberta. The map scale is 1 mile to 1 inch with a contour interval of 100 feet. About 250 square miles were completed.

E. E. Freeland made a series of control surveys for the preparation of the Missinaibi map-sheet, in Michipicoten district, Ontario. The greater part of this work consisted of primary transit and tape traverse along the Canadian Pacific railway from Franz to the point, a short distance east of Shumka, where Speight's meridian intersects the railway. The traverse is about 45 miles long and is for the control of the geographical mapping in the area.

K. G. Chipman mapped about 140 square miles of country in the vicinity of Broughton, Quebec, on the scale of 1 mile to 1 inch with a contour interval of 50 feet. In this work valuable assistance was rendered by Major J. B. Cochrane, Assistant Director of Military Surveys, who furnished a plot of the complete surveys of all the roads in the area. These roads had been surveyed by the Department of Militia and Defence in connexion with their projected mapping of the area.

A. G. Haultain mapped an area of 150 square miles to the south and west of Moncton, New Brunswick. This work was done on the scale of 1 mile to 1 inch with a 50-foot contour interval. The work adjoins the Moncton map-area previously mapped by this division in 1911.

OFFICE WORK

C. H. Freeman was retained in the office during the summer to assist in completing some of the back work of compilation and drawing topographical and geographical maps.

S. G. Alexander was engaged in carrying on the compilation and preparation of the special maps of the Fraser River delta and Greater Vancouver.

C. L. C. Allinson was attached to the division during the year as a temporary employee and rendered efficient service in the field and office.

MINERALOGICAL DIVISION

Eugene Poitevin, Acting Chief of the Division, reports as follows:

The Division of Mineralogy comprises a Museum of Economic Mineralogy, a mineralogical laboratory, and a section devoted to the preparation of educational collections. The staff consists of the Chief of the Division, two mineralogists, one rock analyst, one preparator and mineral collector, one clerk-stenographer, and two museum helpers.

Owing to ill health R. A. A. Johnston, Chief of the Division, was compelled to take six months' leave of absence from November 1, 1921. During this absence Eugene Poitevin has acted as Chief of the Division. Mr. Poitevin's field work is referred to on page 7.

LABORATORY AND OFFICE WORK

A large number of minerals from all over Canada were received for examination. Seven hundred and fifty memoranda were furnished as follows:

Yukon Territory ..	5
Alberta ..	12
British Columbia ..	159
Saskatchewan..	41
Manitoba ..	18
Ontario ..	149
Quebec ..	149
Nova Scotia ..	137
New Brunswick ..	32
Prince Edward Island ..	4
Geological Survey Branch ..	32
Mines Branch ..	12
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Personal inquiries on the part of visitors seeking information on various matters pertaining to the mining industry were numerous, and, although no record of them was kept, required the expenditure of probably 10 per cent of the total working time.

The following papers have been published by officers of the division:

"The Annaheim Meteorite," by R. A. A. Johnston, F.R.S.C., and H. V. Ellsworth, M.Sc., Ph.D., Transactions of the Royal Society of Canada, Sec. IV, 1921.

Bulletin No. 32. "Inyoite from New Brunswick," by Eugene Poitevin and H. V. Ellsworth.

"Camsellite, a New Borate Mineral from British Columbia, Canada," by H. V. Ellsworth and Eugene Poitevin, Transactions of the Royal Society of Canada, Sec. IV, 1921.

Miss F. H. B. Richardson in addition to performing the stenographic work of the technical staff and its associated duties, has been occupied with the revision of the "List of Canadian Mineral Occurrences," Memoir No. 74.

M. F. Connor, rock analyst, completed analyses of eight minerals and five rock samples.

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MUSEUM OF ECONOMIC MINERALOGY

This museum is maintained for the benefit of the public interested in the mineral industry, for students of mineralogy, and for the general public. For over half a century the Division of Mineralogy has been called upon at different times to prepare mineral collections for international expositions and the diplomas in its possession record the success it has achieved. This year a large collection of minerals representative of the leading Canadian mining camps was displayed at the Seventh National Exposition of Chemical Industries in the Eighth Coast Artillery Armory, New York, September 12-17.

EDUCATIONAL COLLECTIONS

A. T. McKinnon, mineral collector, spent one week collecting specimens in the Gatineau district, Quebec.

During the year ninety-one collections containing 3,252 mineral specimens have been assembled, and issued to educational institutions in Canada and elsewhere, as follows: British Columbia 4; Alberta 1; Saskatchewan 2; Manitoba 3; Ontario 37; Quebec 29; New Brunswick 4; Nova Scotia 2; foreign 9.

PALÆONTOLOGICAL DIVISION

E. M. Kindle, Chief of the Division, reports as follows on the work of the division.

FIELD WORK

The field work of Messrs. Kindle, McLearn, Whittaker, and Bell is referred to on pages 5, 6, and 8.

C. M. Sternberg spent two weeks collecting vertebrate and plant remains on Rocky creek, southern Saskatchewan. These collections in addition to their interest as museum specimens will contribute important evidence to the age determination of the beds which succeed the Fox Hills formation. The rest of the field season was spent in Red Deer valley, Alberta, where a carload of dinosaurian remains were collected from the Belly River series. A short collecting trip was also made to the fish beds near Banff which were discovered by Survey palæontologists a few years ago. A number of specimens were secured which will add one or more species to the fish fauna known previously from these beds.

OFFICE WORK

The office work of the division falls under two general heads.

(1) *The preparation of short reports designed for the use of members of other divisions of the Geological Survey.* Such reports are ordinarily based on collections of fossils made by geologists in connexion with areal mapping or the preparation of reports on economic geology. These reports which are made for other members of the staff at their request enable them to assign the formations with which they have to deal to their proper relative position in the general geological scale.

(2) *Research work on palæontological collections and problems related to such collections.* In collections of fossils from the west and northwest 50 per cent or more of the species are often found to be new to science. The description of such slightly known faunas and their proper correlation are of fundamental importance. Without in this way keeping the science of palæontology abreast of the discoveries

made by the extension of the work of the Survey over extensive fields, the division cannot hope to properly or adequately meet the needs of the members of the staff who require reports dealing with questions of correlation. The five papers recently published in Bulletin 33 illustrate the character of some of the shorter contributions of this division to this kind of work. These are: "Faunal and Sediment Variation in the Anticosti Sequence," by W. H. Twenhofel; "New Species of Devonian Crinoidea from Northern Canada," by Frank Springer; "The Range of Certain Lower Ordovician Faunas of the Ottawa Valley, with Descriptions of Some New Species," by Alice E. Wilson; "The Fossil Molluscan Fauna of the Marl Deposits of the Ottawa District," by E. J. Whittaker; "Two New North American Cycadeoids," by G. R. Willard.

Investigations concerning the accumulation or deposition of sediments have been undertaken both in the office and in the field to evaluate the significance of the physical features everywhere associated with sedimentary rocks and to infer from these the physical environments and their probable influence on fossil faunas. Investigations in this field during the year have included the fresh, brackish, and marine deposits and faunas of the Lake Melville district, Labrador, and the small lakes near Ottawa.

EXHIBITS

The installation of exhibits in the hall of palaeontology in the Victoria Memorial Museum has continued throughout the year. The additions to these exhibits include a synoptic series of invertebrate fossils which was assembled by Miss Grace Stewart and the mounting of a fossil tree trunk 52 feet in length by Mr. Skillen.

DONATIONS

The donations received include fossils from Mr. M. J. O'Brien, Miss Fyles, and Mr. J. A. Ritchie.

BORINGS DIVISION

E. D. Ingall, Chief of the Borings Division, reports as follows:

The work of collecting information regarding boring operations throughout Canada has been continued substantially along the lines formerly pursued. An endeavour is being made to secure as much as possible of the geological information regarding the strata penetrated in borings for natural gas, petroleum, salt, water, etc. By securing the co-operation of those in charge of boring operations, records of wells are being accumulated which give particulars as to the mode of occurrence of the mineral products mentioned. The geological conditions affecting such occurrences can, furthermore, be worked out through the study of the complete sets of samples secured from the operators.

It is recognized that failing the collection of such illustrative sets of samples, our knowledge of the geological conditions in depth over the Great Plains and other large areas of Canada must be limited to surmise based on the surface study of very scattered and imperfect outcroppings of the various formations. Unfortunately the individual operator is as yet not fully appreciative of the value to him as well as to others of the accumulation of data and of its interpretation for his benefit by the geologist. For this reason the efforts to secure co-operation involve considerable educative work and a voluminous correspondence.

About sixty thousand samples have been accumulated since the inauguration of the Borings Division in 1908. These are filed under a system which ensures them being promptly available at any time. A final, complete, and intensive study of this material will be made, but to meet the needs of the driller during the progress of his work, special microscope and chemical preliminary determinations and correlations with known geological sections are also performed.

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The initial problem of obtaining clues to boring operations, active or in contemplation, is solved in various ways. Some information comes through newspaper clippings, and through individuals. Use has been made of the Vancouver office of the Geological Survey for British Columbia activities and an attempt has been made to interest the Provincial Government engineers in charge of districts. The field geologists of the staff of the Geological Survey have also co-operated in making inquiries during the course of their summer field work. Arrangements have also been made with the Mining Lands and Yukon Branch of the Department of the Interior for securing information regarding borings in the northwest provinces and territories coming under their jurisdiction. In Manitoba close co-operation has been accorded by Mr. H. F. Ratheram, Superintendent of Drilling, for the Manitoba Government, especially in connexion with the important boring at Winnipegosis. In Ontario a basis of co-operation has been arranged between the Borings Division and the Commissioner of Gas for Ontario. This has operated successfully during the year, thanks to the sympathetic help rendered by Col. R. B. Harkness, the Commissioner.

Among other persons or companies too numerous to mention individually, thanks are tendered to the following who have taken special interest in the work of the Borings Division and rendered great help in prosecuting the same: The New Brunswick Gas and Oil Co., and the D'Arcy Exploration Co. for their help continued now through many years; W. B. McKenzie, Moncton, N.B. In Ontario besides the general co-operation of Col. Harkness, Commissioner of Gas, thanks are tendered to Messrs. F. J. Carman, E. P. Rowe, D. A. Coste, Mgs. Provincial Natural Gas Co.; The Brunner Mond Co.; Geo. Sheppard of the Blue Mountain Gas and Oil Co.; The Public Utilities Commission of London, Ontario; The Municipal Water Commission of Kitchener, Ont.; H. Friend, drilling contractor for borings in Ottawa; and numerous others. In Manitoba besides the close co-operation rendered by H. F. Ratheram, Superintendent of Well Drills, help has been rendered by R. C. Wallace, Commissioner for Northern Manitoba; S. Eagle, Dauphin, Man.; Capt. E. Dougherty, for the Northern Manitoba Oil Co. For Alberta and Saskatchewan borings, especial thanks are due Mr. J. Ness of the geological staff of the Imperial Oil Co. and to other officials of that company; to A. M. Slack in connexion with borings in the Peace River district; J. H. Mahon for the Fort Norman Oil and Development Co.; the West Regent Oil and Development Co. For general co-operation in Alberta, thanks are tendered to Dr. J. A. Allan, University of Manitoba. In British Columbia, the operators of the following especially interesting borings have sent in samples, etc. The Boundary Bay Oil Co.; the Columbia Oil Co.; and the Crows Nest Oil Co.; and thanks are due for co-operation to E. S. Estlin of Vancouver, B.C. Special help has been given by the following officials of the Dominion Government; O. S. Finnie, B. Sc., Inspecting Engineer, Mining Lands and Yukon Branch, Ottawa; Sidney Ells of the Mines Branch, Department of Mines, Ottawa; the staff of the Vancouver office of the Geological Survey.

List of Samples and Records Received, 1921

Locality	Number of samples received	Number of wells	Number of records received
Maritime Provinces.....	2,049	17	162
Quebec	7	3	3
Ontario	3,151	58	147
Northwest Provinces	1,081	12	208
British Columbia.....	55	3	25
Total	7,243	93	545

A large number of samples are promised from The Imperial Oil Co., Ltd.

GEOGRAPHICAL AND DRAUGHTING DIVISION

C.-Omer Sénécal, Geographer and Chief Draughtsman, reports as follows:

During the past fiscal year, two experienced members of the division resigned their positions after nine to twelve years' service to accept more lucrative appointments elsewhere, and no suitable successors have yet been obtained. The salaries offered do not seem to be sufficient to attract and hold in the service the required type of men.

The remaining staff, composed of the Chief of the Division, three principal map draughtsmen, three senior map draughtsmen, one geological engraver, and two clerks—all of whom discharged their duties faithfully and efficiently—are barely able to cope with the demands made on the division.

During the fiscal year seventy-nine new maps were completed and published; fifteen other maps are in the hands of the King's Printer; and thirty-four others are at various stages of progress of compilation or preparation for reproduction and printing. Among the last are two important maps, which were undertaken a few years ago, of large areas of the provinces of Ontario and Quebec, to consolidate, into generalized form, the geological studies and explorations which have been made of the various fields covered by these maps. The Ontario map, compiled on a scale of 8 miles to 1 inch, and engraved on copper, extends from the interprovincial boundary at lake Timiskaming westward to lake Superior and from lake Huron northward to latitude 50 degrees, embracing an area of approximately 90,000 square miles. The Quebec map covers the northwestern part of the province, adjacent to the Ontario map, between latitudes 47 degrees and 52 degrees and between the meridian of lake St. John and the interprovincial boundary, an area of about 140,000 square miles.

Three detailed maps of parts of Algoma district, Ontario, in the vicinities of Bruce Mines, Blind River, and lake Panache are nearly completed. The assembling of new surveys and explorations on the Nova Scotia series of geological sheets has been resumed. Control surveys were laid on eight new sheets of Queens and Shelburne counties and, if possible, the compilation is to be continued uninterruptedly to completion during the coming year. Four sheets, Nos. 87, 88, 89, and 90, Lunenburg county, the compilation of which was thoroughly revised, are ready for engraving, and the preparation of the engraver's copy only awaits the completion by the geologist of geological drafts, legends, sections, and other marginal information. The compilation is on the scale of 1 mile to 1 inch, and each sheet covers 216 square miles.

An unusually large number of zinc-cut drawings of index maps, diagrams, text figures, etc., have also been executed for illustrating memoirs and reports, and for other purposes. Two special maps of southern Manitoba were also prepared for publication in a report on the Agricultural college of Manitoba. Map-sheets of the survey of Fraser river, B.C., undertaken and completed in the Topographical Division, also passed through this office for publication. These sheets are included in the subjoined list of published maps.

The cataloguing of the Survey's records is steadily progressing, under the supervision of H. Lefebvre, who is also acting as Assistant Chief of the Division. Up to the present, 1,100 field books have been entered on index cards, and an equal number have been temporarily classified in groups by authors and years. Some 10,000 other map records of all descriptions, out of the Survey's large collection, have also been permanently catalogued.

As a representative of the Geological Survey, the Chief of this Division attended the meetings of the Geographic Board of Canada, and, as member of the executive committee of this board, devoted considerable time to the study and discussion of place-nomenclature and other geographical subjects. Rules of nomenclature, and lists of approved names, intended for use in all official publications of the Dominion Government, are published periodically in the *Canada Gazette*, and in the reports of the board.

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The following are lists of maps remaining in the hands of the King's Printer, on March 31, 1922, and maps published during the fiscal year:

Maps in Hands of King's Printer, March 31, 1922

Publication number	Title	Date of requisition
155A, 1553	Algoma, Sudbury, and Timiskaming districts, Ontario; scale, 8 miles to 1 inch	Dec. 15, 1919
1585	Mackenzie River basin, northwestern Canada; scale, 50 miles to 1 inch. Third revised edition	Feb. 1, 1922
1897	Coquihalla River area, Yale district, British Columbia; scale, 1 mile to 1 inch. Topographical map	Oct. 20, 1921
1926	Kenogami Lake area, Timiskaming district, Ontario; scale, 1 mile to 1 inch	Feb. 27, 1922
1927	Round Lake area, Timiskaming district, Ontario; scale, 1 mile to 1 inch	Feb. 27, 1922
1932	Larder Lake area, Timiskaming district, Ontario; scale, 40 chains to 1 inch	March 8, 1922
1933	Fraser River delta, British Columbia; scale 1 mile to 1 inch. Topographical map	Feb. 2, 1922
1935	Part of Lemieux township, Gaspé county, Quebec; scale, 4,000 feet to 1 inch	Feb. 27, 1922
1936	Shields, Gaudette, Deroche, and Hodgins townships, Algoma district, Ontario; scale, 1 mile to 1 inch	Feb. 22, 1922
1937	Rambler Hill area, Mayo district, Yukon; scale, 2,000 feet to 1 inch	March 16, 1922
1940	Mount Cameron area, Mayo district, Yukon; scale, 2,000 feet to 1 inch	March 6, 1922
1941	Part of Antler creek, Cariboo district, British Columbia; scale, 1,000 feet to 1 inch	March 6, 1922
1742	Part of Williams creek, Cariboo district, British Columbia; scale, 1,000 feet to 1 inch	March 6, 1922
1743	Stand-to Hill area, Mayo district, Yukon; scale, 2,000 feet to 1 inch	March 6, 1922
1945	North Thompson valley, between Joseph creek and Louis creek, Kamloops district, British Columbia; scale, 2 miles to 1 inch. (Preliminary map)	March 28, 1922

Maps Published April 1, 1921, to March 31, 1922

Publication number	Title	Remarks
	YUKON	
1860	Keno Hill area, Mayo district; scale, 2,000 feet to 1 inch	Geology and topography
	MACKENZIE	
1872	Sketch map showing approximate geological structure of the Norman-Good Hope area, Mackenzie river; scale, 10 miles to 1 inch	Geology
1873	Sketch map showing the geology along Mackenzie river between the Ramparts and the Delta; scale, 43 miles to 1 inch	Geology
	BRITISH COLUMBIA	
1829	Salmon River area, Portland Canal mining division, Cassiar district; scale, 4,000 feet to 1 inch	Geology
1842	Forrest Group limonite deposits, Taseko valley, Lillooet district; scale, 4,000 feet to 1 inch	Geology
1843	Denain Creek limonite deposits, Taseko valley, Lillooet district; scale, 400 feet to 1 inch	Geology
1844	Feo Creek limonite deposit, Taseko valley, Lillooet district; scale, 400 feet to 1 inch	Geology
1845	Rae Creek limonite deposits, Taseko valley, Lillooet district; scale, 400 feet to 1 inch	Geology
1846	Battlement Creek limonite deposits, Taseko valley, Lillooet district; scale, 400 feet to 1 inch	Geology

Maps Published April 1, 1921, to March 31, 1922—Continued

Publication number	Title	Remarks
1847	Chilcotin Group limonite deposits, Taseko valley, Lillooet district; scale, 400 feet to 1 inch.....	Geology
1848	Limonite Group deposits, Taseko valley, Lillooet district; scale, 400 feet to 1 inch.....	Geology
1849	Taseko River area, Lillooet district; scale, 3,000 feet to 1 inch.....	Geology
1850	Float observations, ebb-tidal and river currents, Fraser river, between Woodward's landing and strait of Georgia; scale, 2,000 feet to 1 inch.....	Physiography
1851	Float observations, flood-tidal currents, entrance of Fraser river and strait of Georgia; scale, 2,000 feet to 1 inch.....	Physiography
1852	River and sea-bottom materials, water density observation and bank erosion, Fraser river between Woodward's landing and strait of Georgia; scale, 2,000 feet to 1 inch.....	Physiography
1853	Comparative soundings, Fraser river, between Woodward's landing and strait of Georgia; scale, 2,000 feet to 1 inch.....	Physiography
1854	Diagram showing the distribution of surface deposits, Fraser River delta; scale, 3 miles to 1 inch.....	Geology
1855	High-water data at Mission Bridge (freshet stages), Fraser river.....	Physiography
1856	Discharge data, Fraser river.....	Physiography
1857	Diagram showing changes in river channels, Fraser river between Woodward's landing and strait of Georgia.....	Physiography
1858	Diagram showing seaward advance of Fraser River delta; scale, 1 mile to 1 inch.....	Physiography
1859	Route map of country between French Bar creek (Fraser river) and Taseko lake, Lillooet district; scale, 6 miles to 1 inch.....	Geology
1901	Upper Kitsault valley (Alice arm), Cassiar district; scale, 3,000 feet to 1 inch.....	Geology and topography
1905	Fraser river, Sand Heads sheet; scale, 1,000 feet to 1 inch.....	
1906	Fraser river, Steveston sheet; scale, 1,000 feet to 1 inch.....	
1907	Fraser river, Ladner sheet; scale, 1,000 feet to 1 inch.....	
1908	Fraser river, Deas Island sheet; scale, 1,000 feet to 1 inch.....	
1909	Fraser river, Tilbury sheet; scale, 1,000 feet to 1 inch.....	
1910	Fraser river, Annacis sheet; scale, 1,000 feet to 1 inch.....	
1911	Fraser river, New Westminster sheet; scale, 1,000 feet to 1 inch.....	
1912	Fraser river, Port Mann sheet; scale, 1,000 feet to 1 inch.....	
1913	North arm of Fraser river, Poplar Island sheet; scale, 1,000 feet to 1 inch.....	
1914	North arm of Fraser river, Boundary Road sheet; scale, 1,000 feet to 1 inch.....	
1915	North arm of Fraser river, Marpole sheet; scale, 1,000 feet to 1 inch..	
1916	North arm of Fraser river, Tone Island sheet; scale, 1,000 feet to 1 inch.....	
1917	North arm of Fraser river, Point Grey sheet; scale, 1,000 feet to 1 inch.	
1918	Burrard inlet, Vancouver sheet; scale, 1,000 feet to 1 inch.....	
1919	Burrard inlet, Second Narrows sheet; scale, 1,000 feet to 1 inch.....	
1920	Burrard inlet, Dollarton sheet; scale, 1,000 feet to 1 inch.....	
1921	Burrard inlet, Barnet sheet; scale, 1,000 feet to 1 inch.....	
1922	Burrard inlet, Port Moody sheet; scale, 1,000 feet to 1 inch.....	
1923	Fraser river, triangulation control.....	
1924	North arm of Fraser river, triangulation control.....	
1925	Burrard inlet, triangulation control.....	
ALBERTA		
1830	Vermilion, townships 47 to 55, ranges 5 to 10, west of fourth meridian; scale 3 miles to 1 inch.....	Topography
1831	Vegreville, townships 47 to 55, ranges 11 to 16, west of fourth meridian; scale, 3 miles to 1 inch.....	Topography
MANITOBA		
1771	Winnipegosis, townships 30 to 37, ranges 11 to 23, west of principal meridian; scale, 3 miles to 1 inch.....	Soil geology
1802	Upper Whitemouth river; scale, 3 miles to 1 inch.....	Soil geology
1838	Rat River route from Threepoint lake to Southern Indian lake; scale, 8 miles to 1 inch.....	Geology
1839	The terminal moraine of the Seal-Churchill divide; scale, 6 miles to 1 inch.....	Geology

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Maps Published April 1, 1921, to March 31, 1922—*Continued*

Publication number	Title	Remarks
1841	Diagram showing Maskwa River nickel-copper deposits; scale, $\frac{1}{4}$ mile to 1 inch.....	Geology
1861	The Oswagan Lake-Burntwood River area; scale, 2 miles to 1 inch.....	Geology
1928	Oiseau River area (township 17, ranges 15 and 16, east of principal meridian); scale, $\frac{1}{4}$ mile to 1 inch.....	Geology
1929	Rice Lake area (townships 23 and 24, ranges 13 and 14), east of principal meridian); scale, $\frac{1}{4}$ miles to 1 inch.....	Geology
ONTARIO		
1836	Explored routes in a belt traversed by the Canadian National railways (between Longlac and Nipigon); Thunder Bay district; scale, 4 miles to 1 inch.....	Geology
1865	Moncrieff and Hess townships, Sudbury district; scale, 1 mile to 1 inch.....	Geology
1875	Beverley peat bog, Beverley and Flamboro W. townships, Wentworth county; scale, 2,400 feet to 1 inch.....	Economic geology
1876	Halton peat bog; Nassagaweya township, Halton county; scale, 1,600 feet to 1 inch.....	Economic geology
1877	Aberfoyle peat bog, Puslinch township, Wellington county; scale, 1,600 feet to 1 inch.....	Economic geology
1878	Pelee Point peat bog, Mersea township, Essex county; scale, 2,400 feet to 1 inch.....	Economic geology
1879	Harrowsmith peat bog, Portland township, Frontenac county; scale, 1,600 feet to 1 inch.....	Economic geology
1884	Thedford peat bog, Bosanquet township, Lambton county; scale, 2,400 feet to 1 inch.....	Economic geology
1885	Maybrooke peat bog, Harley and Kerns townships, Timiskaming district; scale, 1,600 feet to 1 inch.....	Economic geology
1886	Nellie Lake peat bog, Newmarket, Aurora, McCart, and Calvert townships, Timiskaming dist.; scale, 2,400 feet to 1 inch.....	Economic geology
1887	Drinkwater peat bog, Matheson township, Timiskaming district; scale, 1,600 feet to 1 inch.....	Economic geology
1889	St. John peat bog, St. John township, Timiskaming district; scale, 1,600 feet to 1 inch.....	Economic geology
1890	Brower peat bog, Brower and St. John townships, Timiskaming districts; scale, 1,600 feet to 1 inch.....	Economic geology
1891	Cochrane peat bog, Lamarche township, Timiskaming district; scale, 1,600 feet to 1 inch.....	Economic geology
QUEBEC		
1835	Beauceville, Beauce county; scale, 4,000 feet to 1 inch.....	Geology and topography
1880	St. Luc peat bog, Champlain county; scale, 2,400 feet to 1 inch.....	Economic geology
1892	Clair peat bog, Dorchester and Bellechasse counties; scale, 1,600 feet to 1 inch.....	Economic geology
1893	St. Joseph peat bog, Lauzon seignior, Dorchester county; scale, 1,600 feet to 1 inch.....	Economic geology
1894	"A" and "B" peat bogs, Isle-Verte seignior, Temiscouata county; scale, 1,600 feet to 1 inch.....	Economic geology
1895	St. Arsène peat bog, Lepage and Lachenaie seignior, Temiscouata county; scale, 1,600 feet to 1 inch.....	Economic geology
1896	St. Anaclet peat bog, Lessard and Lepage-Thibierge seignior, Rimouski county; scale, 2,400 feet to 1 inch.....	Economic geology
1899	Direction of local glaciers, Gaspé peninsula, Quebec; scale, 12 miles to 1 inch.....	Surface geology
1934	Federal Zinc and Lead mine and vicinity, Lemieux township, Gaspé county; scale, 400 feet to 1 inch.....	Geology
NEW BRUNSWICK		
1888	Cudmore, Hicks, "B", Canaan, Gades, and "A" peat bogs, Moncton parish, Westmorland county; scale, 2,400 feet to 1 inch.....	Economic geology
1931	Rosevale oil-shale area, Albert county; scale, 800 feet to 1 inch.....	Geology

MAP ENGRAVING DIVISION

Robert Veitch, in charge of the Map Engraving Division, reports as follows:

An arrangement was consummated in December, 1921, between the Labour (Printing and Stationery Branch), Department of Interior (Natural Resources Intelligence Branch), Mines (Geological Survey), and Naval Service (Hydrographic Survey), whereby the staff of copper-plate map engravers hitherto maintained by the Department of Public Printing and Stationery was distributed among the Natural Resources Intelligence Branch, Geological Survey, and Hydrographic Survey. By this arrangement, four engravers, Robert Veitch, J. W. Tuttle, A. Stewart, and W. W. Arnold were allotted to the Geological Survey on December 5. These four engravers, though still officially part of the staff of the Department of Public Printing and Stationery, have quarters with the Geological Survey and operate for all practical purposes as part of the Survey organization.

Between December 5, 1921, and March 31, 1922, the staff has been partly engaged in completing for the Post Office Department the engraving of a series of postal maps; a chart for the Naval Service (Hydrographic Survey); and completing the topographic plates of the Coquihalla River area, Yale, B.C., map, which were in progress at the time of transfer. In addition plates for the Fraser Delta topographic map (Geological Survey) have been commenced and brought well towards completion.

PHOTOGRAPHIC DIVISION

G. G. Clarke, Chief Photographer, reports that the following work was done by the Photographic Division:

	Number
Contact prints, 4 by 5 inches to 36 by 48 inches..	14,217
Bromide enlargements, 4 by 5 inches to 40 by 72 inches	807
Films and plates developed, 3½ by 4½ inches to 6½ by 8½ inches.. . .	3,830
Dry plate negatives, 4 by 5 inches to 11 by 14 inches	286
Wet plate negatives, 8 by 10 inches to 24 by 30 inches	176
Prints on zinc plates, 11 by 14 inches to 24 by 36 inches	97
Proofs from zinc plates, 11 by 14 inches to 24 by 36 inches	75
Photostat copies, 7 by 11 inches to 11 by 14 inches	55
Lantern slides, 3½ by 4 inches	1,389
Photographs and titles mounted	1,539
Total .. .	22,471

The Geological Survey collection of photographs now comprises 55,000 negatives. These pictures have been accumulated by officers of the Survey chiefly during the last fifty years and are representative of all parts of Canada, and from the United States boundary to the Arctic ocean. They cover an extraordinary range of interesting subjects and many of the older ones have now acquired historical value as records of the progress and development of the country. In order to make this collection more available to the public a set of photographic prints, mounted and classified according to subjects, is being prepared and placed in the Geological Survey library. An arrangement has also been made recently whereby, as time permits, photographic prints, enlargements, and lantern slides will be made on request from persons outside the Department at about the cost of preparation. Advance photographic copies of maps, photostat reproductions of pages from rare reports, and other work of the kind will also be done. This work for the public will be subordinated to the official photographic work for the Department of Mines and will be executed in an amount dependent upon the resources of the Photographic Division, which is at present in need of an additional photographer.

Photo prints, unmounted.. . . .	½ cent per square inch
Enlargements	1 " "
Maps from wet plate negatives (on paper) .. .	1 " "
Maps from wet plate negatives (on linen) .. .	1 " "
Photostat negatives and prints	1 " "
Mounting of prints	1 " "
Lantern slides from negatives on file.. . . .	10 cents each

Wyatt Malcolm, Chief of the Division, reports:

The distribution of the publications of the Geological Survey and of the Victoria Memorial Museum is made by this division. During the year, 73,992 publications, exclusive of the French editions, were distributed. Of these 24,520 were sent to addresses on the mailing lists and 49,472 were distributed in compliance with written and personal requests for named publications or requests for general or specific information.

The Division consists of a chief and five assistants.

Mrs. F. E. Forsey, Librarian, reports that the library now contains over 40,000 volumes, including almost all the important scientific and technical publications treating of the subjects in the work of the Survey and Museum, as well as the necessary guides, bibliographic aids, and reference books.

The additions during the year were as follows:

Volumes received as gifts or exchanges	533
Books purchased	379
Periodicals subscribed for	171
Periodicals received in exchange	88
Maps received	192
Pamphlets received	241

This statement does not include publications appearing in parts, such as the results of the various scientific expeditions, namely the Canadian Arctic Expedition, the Swedish South Polar, the Danish Ingolf, and the Australasian Antarctic expeditions, and others being purchased by or presented to the Library.

The volumes collated and prepared for the binder numbered 505; several bibliographies were prepared by the staff and a number of letters and other papers translated from foreign languages for other divisions of the Survey.

The cataloguing included current accessions, and the analytical cataloguing of such older sections of the collection as State Geological Surveys, as well as sixteen

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sets of periodicals. The classification scheme and the catalogue have served as guides for the librarians of a number of government libraries who have visited us from time to time.

Considerable progress has been made in the classification and arrangement of the maps, photographs, and lantern slides. The cataloguing of the 1,228 Canadian maps in the collection has been brought up to date and the maps of other countries are arranged according to a system that makes them easily accessible.

The lantern slides filed in the library now number 1,423, of which 693 have been catalogued during the year. The slides have been in constant use, not only by the staff of the Survey, but also as loans to educational institutions for lecture purposes.

The collection of photographs, illustrating as it does the work of the Survey and Museum staffs and covering the fields of geology, palaeontology, economic geology, anthropology, biology, etc., has proved extremely useful and has been frequently consulted by visitors as well as by the members of the Department.

By a system of library loans, scientific men in any part of Canada may borrow books required in research work. Individuals not known to the Department may obtain books through any library willing to accept the responsibility of having the conditions of loan properly discharged. During the year books have been loaned in this way to scientific workers in five provinces, in eight universities, and very frequently to the various departmental libraries situated in Ottawa.

VICTORIA MEMORIAL MUSEUM

William McInnes, Director

The exhibits in the halls of the Victoria Memorial Museum building have been considerably augmented during the year and the study collections very much increased. The public of Ottawa and visitors from other parts of the world have shown their appreciation of the exhibits by attending in constantly increasing number as the fact that the exhibition halls were again open to the public became more generally known.

The maintenance of a display of exhibits open to the public, though an important part of the functions of a national museum, is by no means its whole duty.

The scientific study of the natural history, anthropology, and paleontology of the country and the accumulation of adequate collections in all these branches are perhaps even more important. The educational value of such an institution is beyond estimate and its adequate maintenance is accepted generally as, in part, a measure of the cultural standing and progressive spirit of the country. The present collections are a nucleus on which may be built a national museum that will worthily represent Canada.

Under the auspices of the Museum and the Geological Survey, two series of public lectures were held in the Auditorium during the winter months, one for children and one for adults. The lectures were illustrated by stereopticon, and by motion pictures, for which the Department is indebted to the Exhibits and Publicity Branch of the Department of Trade and Commerce. The children's meetings were particularly successful and lectures in this series had more than once to be repeated one, and even two times, to accommodate the crowd of appreciative youngsters. The programme carried out included the following lectures, each given for school children and repeated in modified form for adults:

- Hunting Dinosaurs—The Real Giants of the Past, by Charles M. Sternberg, Geological Survey. Moving picture: Hunting Dinosaurs.
- Asbestos or Fire-Proof Cotton, by R. Harvie, Geological Survey. Moving picture: Asbestos Mining.
- Animal Life of our Pacific Coast Islands, by Clyde L. Patch, Victoria Memorial Museum. Moving picture: Salmon Fishing on the Skeena.
- Water Power or White Coal, by E. J. Whittaker, Geological Survey. Moving picture: Water Powers of Canada.
- The Indians of the Plains, by D. Jenness, Victoria Memorial Museum. Moving picture: The Last of the Bison.
- Modes of Crossing Canada—from Canoe to Aeroplane, by F. J. Alcock, Geological Survey. Moving picture: Building Aeroplanes.
- The Glacial Age, by M. E. Wilson, Geological Survey. Moving picture: The Valley of the Yoho.
- Pioneer Days in British Columbia, by C. M. Barbeau, Victoria Memorial Museum. Moving picture: Vancouver—The Queen of the Coast.
- Our Selkirk Mountains and their Precious Metals, by M. F. Bancroft, Geological Survey. Moving picture: The Robson Trail.
- Down the Mackenzie River to the Oil Fields, by D. B. Dowling, Geological Survey. Moving picture: Down North.
- Northern Ontario's Natural Resources, by T. L. Tanton, Geological Survey. Moving picture: Mining in Northern Ontario.
- My Summer in the Norway of Canada, by Harlan I. Smith, Victoria Memorial Museum. Moving picture: The Norway of America.
- Boring Deep Wells for Valuable Minerals, by E. D. Ingall, Geological Survey. Moving picture: A World of Scenic Wonder.

D. B. Dowling, Harlan I. Smith, Lecture Committee.

Some of the lectures were repeated by request in other parts of the city and in neighbouring towns.

The Auditorium, on otherwise unoccupied nights, was lent to various scientific societies, thirty-six meetings of this character having been held, including those of the Royal Society of Canada, the Engineering Institute of Canada, and societies with like aims. The privilege to use such a meeting place was highly appreciated by the various societies and their thanks to the Department of Mines were in many cases expressed in formal votes.

Pending the completion of arrangements for this permanent transfer to the Museum staff Mr. M. O. Malte acted as Honorary Curator of the Herbarium and the thanks of the Department are due to him for assuming this work in addition to his ordinary duties in the Department of Agriculture.

A summary account of the field work of the staff is included in the divisional reports.

ANTHROPOLOGICAL DIVISION

ETHNOLOGY AND LINGUISTICS

Exhibits

E. Sapir, Chief of the Division, reports that the anthropological exhibits in the Victoria Memorial Museum have remained almost unchanged and fully accessible to the public during the year. The lack of both sufficient space and suitable cases is keenly felt.

Acknowledgments are due to the following for donations of specimens or photographs to the Museum: F. Macnamara, E. Z. Massicotte, Miss Parmelee, and Father Turquetil.

Five anthropological field trips, undertaken during the summer, evince progress towards the restoration of pre-war conditions in the Division of Anthropology. Of these trips one was a combined archaeological and ethnological trip to Bella Coola, B.C., undertaken by H. I. Smith. A second was an intensive archaeological field research in a village site near London, Ont., of a culture different from those hitherto intensively studied. This trip, as well as the archaeological part of Mr. Smith's field work, are reported under "Archæology". D. Jenness spent two months investigating the social organization and history of the Sarcee Indians of Alberta. F. W. Waugh left Ottawa in May to investigate the Nascopi Indians of northern Quebec, and continued the work throughout the year. T. F. Mellwraith began an investigation of the social organization, religion, and allied topics of the Bella Coola Indians of British Columbia.

E. Sapir continued to work on the large body of Nootka text material obtained in the field and from Indian interpreters. This material is far too bulky to be published in the form of a single volume but should appear as a series of text volumes. The first volume is nearing completion. It consists of a set of Nootka tales and of a larger set of selected texts intended to illustrate various phases of Nootka ethnology. The texts are being carefully edited, annotated, and translated; a limited proportion of the text material is provided with an interlinear translation for the use of the linguistic student. In later volumes it is planned to include other ethnological texts and the large set of family legends and origin myths on file in the division. The linguistic-sociological review of the kinship systems of Algonkin, Wiyot, and Yurok, previously reported on, is now completed and will, it is hoped, be published in the near future. A Paiute dictionary was prepared which will, in all likelihood, be published by the University of Pennsylvania. The general American Indian linguistic researches previously referred to were continued. The following

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papers resulting from these researches were published: "The Hokan and Coahuiltecan Languages" (International Journal of American Linguistics, I, 1917-20, pp. 280-90); "A Note on the First Person Plural in Chimariko" (International Journal of American Linguistics, I, 1917-20, pp. 291-94); "A Bird's-eye View of American Languages North of Mexico" (Science, N.S., October 28, 1921, p. 408). As first instalments in a series of Nadene studies, were prepared "An Athabaskan Type of Relative" and "The Phonetics of Haida." In the course of the year Harcourt, Brace and Co. (New York) published a general work by Mr. Sapir entitled "Language, an Introduction to the Study of Speech"; this is mentioned here because it embodies a certain amount of material based on Canadian linguistic researches.

H. I. Smith spent about three months in the Bella Coola Indian area of British Columbia, continuing the work which he began last year. This research was devoted partly to archaeological reconnaissance, but mainly to a study of the material culture of the Bella Coola Indians. Mr. Smith's researches were supplemented by a collection of ethnological objects, some of which were from Carrier Indians who were visiting Bella Coola. He also secured skeletal remains, a plaster of Paris life mask, and photographs of Bella Coola technology and Carrier types.

D. Jenness has been continuing his work on the Eskimo reports in the Canadian Arctic Expedition series. His first memoir, "The Life of the Copper Eskimos", a volume of 277 closely printed pages, was published in January, 1922, by the Department of the Naval Service. This work was very highly reviewed by the *London Times*. Two memoirs, "Myths and Traditions from Alaska, the Mackenzie Delta, and Coronation Gulf", and "String Figures of the Eskimos" are now ready for the press; a fourth memoir, "The Songs of the Copper Eskimos", undertaken in collaboration with Miss Helen H. Roberts of New York, is nearing completion, and considerable progress has been made with two others. Mr. Jenness has also published during the past year two articles on Eskimo subjects; one, "The Cultural Transformation of the Copper Eskimos" appeared in the *Geographical Review*, October, 1921; the other "The 'Blond' Eskimos", in the *American Anthropologist*, October-December, 1921. In addition to this work Mr. Jenness spent the two months of July and August, 1921, among the Sareee Indians of Alberta, gathering information relating to their earlier organization and history. This important tribe had been greatly neglected hitherto, and was represented in the Museum by only four specimens; as a result of Mr. Jenness' visit, however, the Museum now possesses a large and fairly representative collection.

F. W. Waugh, who left Ottawa in May to investigate the Nascopi Indians of northern Quebec, went into the interior from Nain. When last heard from he had done a considerable amount of work on the material culture of the Nascopi. As they were greatly reduced in numbers during the winter of 1918-1919, there is little likelihood that information can be obtained from them unless it is secured soon. Mr. Waugh has also had an opportunity to investigate the material culture of the Eskimo of the Labrador coast.

The following manuscripts have been completed during the year and await publication:

"An Athabaskan Type of Relative," by E. Sapir.

"The Phonetics of Haida," also by E. Sapir.

"Myths and Traditions from Alaska, the Mackenzie Delta, and Coronation Gulf," by D. Jenness.

"String Figures of the Eskimos," also by D. Jenness.

In addition the following manuscripts have been received:

"Songs of the Copper Eskimo, a Transcription of Phonograph Records with a Discussion of the Music," by Miss Helen H. Roberts.

"Eskimo Physical Anthropology," by Professor John Cameron.

"Ethnological field notes on the Tahltan and Kaska or Southern Nahane," by James A. Teit.

Six manuscripts relating to the Nootka Indians, five of them consisting of texts and translations, by Alex. Thomas.

*Accessions**Accessions of Ethnological Specimens*

Specimens collected in course of field work by members of the Division of Anthropology include:

By H. I. Smith:

98 Bella Coola specimens from Bella Coola, B.C.
23 Carrier " "
1 Chilcotin " "

By D. Jenness:

129 Sarcee specimens from Sarcee Reserve, Calgary.
3 Assiniboine " "
1 Blackfoot " "
1 Cree " "

There have been received as gifts:

From F. Macnamara:

1 crooked knife, from Arnprior, Ont.

From E. Z. Massicotte:

1 woven belt, from Montreal, Que.

From Miss Parmelee:

Pair of model snowshoes from Tadoussac.

There have been acquired by purchase:

From Captain Joseph F. Bernard:

256 Eskimo specimens from Siberia, Alaska, Coronation gulf, and Adelaide peninsula.

In physical anthropology the following accessions have been received:

From H. I. Smith:

4 complete skeletons, a skull, and parts of 3 skeletons from vicinity of Ocean Falls, B.C.

From Dr. J. M. Swaine:

Fragment of skull from Okanagan, B.C.

From Miss Parmelee:

Jaw of child from Milk River, Alberta.

Accessions of Phonographic Records

Records taken by officials connected with the Division of Anthropology:

By D. Jenness:

45 records comprising 74 Sarcee songs, from Sarcee Reserve, Alberta.

By J. A. Teit:

24 records from Thompson river, Okanagan and Kootenay Indians.

Accessions of phonographic records of European folk-lore themes are recorded elsewhere.

Photographic and Draughting Work

Ethnological photographs taken or collected for the Museum by officers connected with the Division of Anthropology:

By C. M. Barbeau:

550 (approx.) Tsimshian and Carrier photographs from Hazelton and neighbourhood.

By H. I. Smith:

53 Bella Coola and Carrier photographs from Bella Coola, B.C.

By D. Jenness:

134 Sarcee photographs from Sarcee Reserve, Alberta.

By Photographic Division:

11 Sioux photographs of members of a delegation visiting Ottawa.

There have been received as gifts from individuals not connected with the Division of Anthropology:

From Father Turquetil:

3 photographs of Eskimos of Chesterfield inlet, Hudson bay.

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Lantern slides made in the course of the year by the Photographic Division for the Division of Anthropology include:

- 2 lantern slides illustrating ethnology of the Sarcee Indians.
- 24 lantern slides illustrating ethnology of the Tsimshian Indians.
- 62 lantern slides illustrating ethnology of the Bella Coola and Carrier Indians.
- 10 lantern slides illustrating French Canadian folk-lore subjects.

FOLK-LORE (1921-22)

(C. M. Barbeau)

In the course of the past year the collections of French and English folk-lore materials deposited at the Victoria Memorial Museum have been considerably increased. The data were received as gifts, with the exception of those obtained in Champlain county, Que., by Mr. E. Z. Massicotte, for which a small appropriation was granted.

(The following list supplements the list in the Annual Report for 1920-21):

Folk-Lore Collections

(French)

The Massicotte (E. Z.) Collection—

- 150 (approx.) song texts collected in Sainte-Geneviève de Batiscan (Champlain county), and in Montreal, from singers of various districts;
- 80 song melodies recorded on the phonograph;
- 3 melodies recorded by ear;
- 1 folk-tale;
- 140 photographs of people, buildings, and technological devices;
- 15 pages of folk rhymes, riddles, etc.
- 2 specimens collected for the museum.

The Lambert (Adélard) Collection—

- 25 folk-tales, mostly from Berthier county;
- 93 song texts;
- 16 song melodies recorded by ear;
- 73 song melodies recorded on the phonograph;
- 12 formulæ and rhymes.

The Barbeau (C. M.) Collection—

- 6 song texts from Gatineau Point (Prescott).

The Cloutier (J. E. A.) Collection—

- 6 anecdotes from L'Islet.

The Mercure (Georges) Collection—

- 2 song texts;
- 1 anecdote.

The Cyr (V. C.) Collection—

- 4 song texts.

Miscellanea: From M. Paul Beau (Montreal), 1 formula, 2 song texts, 5 photographs; from M. Régis Roy (Ottawa), 1 folk-tale; from M. Gustave Lanctot, 1 song text; from Mr. Irving Hallowell (Philadelphia), 2 French-Abenaki werewolf anecdotes.

Totals for the Year:

- 257 song texts;
- 153 song melodies recorded on the phonograph;
- 19 song melodies recorded by ear;
- 24 folk-tales;
- 12 anecdotes;
- 145 photographs;
- 2 specimens;
- A considerable number of folk rhymes and riddles.

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*(English)**The J. A. Teit Collection—*

91 MS pages of various data: nursery rhymes, riddles, omens, beliefs, recorded along Fraser river, B.C.

The Hay Shaw (Beatrice M.) Collection—

Several newspaper clippings in which the collector (from Antigonish, N.S.) has embodied data on folk beliefs, legends, and anecdotes from the Maritime Provinces.

The Sells (Mae) Collection—

8 nursery rhymes and riddles from Northants, England.

ARCHAEOLOGY

H. I. Smith reports that the archaeological exhibits have remained open to the public during the year.

Accessions

The accessions to the archaeological collections are as follows:

Collected by Officers of the Division

Accession 253. Archæological specimens. From British Columbia. Collected by H. I. Smith.

Accession 254. Archæological specimens. From Lawson farm site, London township, Middlesex county, Ontario. Collected by W. J. Wintemberg.

Accession 251. Archæological specimens. From Alaska and Arctic coast of Canada. Collected by Canadian Arctic Expedition. Received from Ethnological Division.

Collected by Officers of the Department

Accession 249. Archæological specimens. From Kootenay lake, B.C. Collected by M. F. Bancroft.

Gifts

Accession 248. Archæological specimens. From near headwaters of Chrome creek, tributary to Scottie creek, a branch of Bonaparte river, B.C. Presented by Mr. D. R. Cameron, District Inspector, Kamloops, B.C.

Accession 250. Archæological specimens. From Islay, Alberta. Presented by Mr. J. Dewey Soper, Guelph, Ontario.

Accession 252. Archæological specimens. From Uren village site, South Norwich township, Oxford county, Ontario. Presented by Master Gordon Uren, R. R. No. 1, Otterville, Ontario.

Accession 255. Archæological specimens. From Ireland. Presented by Dr. Hugh Fleming, Ottawa, Ontario.

Accession 256. Archæological specimens. From Ontario. Presented by Miss Faith Fyles, Ottawa, Ontario.

Purchases

Accession 256. Two celts and a combination celt-gouge. From Masson, Quebec. Purchased from Mr. George Albert Robitaille, Buckingham, Quebec.

Field Work and Research

Archæological exploration was carried on in British Columbia by H. I. Smith and in Ontario by W. J. Wintemberg.

British Columbia. The archæological exploration carried on in British Columbia by Mr. Smith was chiefly a continuation of the work begun by him last year in the Bella Coola Indian area, and was prosecuted as a part of his studies of the whole material culture of the area from ancient to recent times. A number of prehistoric shell-heaps, village sites, forts, and pictures and sculptures on rocks were located. Photographs were taken of two sculptured rock pictures on Elcho harbour. A series of such pictures on the west side of the canyon of the stream entering Bella Coola river from the south about 4 miles above its mouth were uncovered, mapped, and photographed. Plaster of paris moulds were made of eight.

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Mr. Smith inspected several archaeological sites near Vancouver which have been largely cleared in recent years, and found a human figure sculptured in stone in a shell-heap in the Fraser delta. This specimen is a unique variation of a type of sculptures. These have come from the area between southeastern Vancouver island and Kamloops. Only a few of these human sculptures are known to have been found. They are widely scattered, the Museums of British Columbia, England, the United States, and Germany, having specimens. This specimen is the first to come into the possession of the Canadian Government.

Ontario. An intensive exploration of the Lawson farm site near London, Ontario, was made by W. J. Wintenberg, from September 22 to November 3. This site is one of the best preserved of the fortified prehistoric village sites in the province. Moulds of the base of its palisade were found and twenty-four large boxes of material, consisting of artifacts of stone, earthenware, shell, bone and antler, pottery fragments, and human and animal bones were secured.

Office Work

In addition to Mr. Smith's work on the report of the archaeological sites and evidences of the Bella Coola area, he assembled the available data and illustrations relating to the bird form in prehistoric Canadian art, the prehistoric picture writings painted on rocks in British Columbia, and the prehistoric human stone sculptures of British Columbia.

Mr. Wintenberg revised, illustrated, and greatly expanded the report on his exploration of the Eisenhauer prehistoric shell-heap on Mahone bay, Nova Scotia. He also completed the first draft of the report on his exploration of the Uren prehistoric village site in Oxford county, Ontario.

BIOLOGICAL DIVISION

R. M. Anderson, Chief of the Division, reports:

Since April, 1921, some progress has been made in the fabrication and preparation of exhibits in the museum halls, although considerable delay has been caused by the inability to obtain proper exhibition cases. Many specimens have been named for the public and information given when requested. Numbers of specimens have also been loaned to schools for the illustration of natural history work, and selected lantern slides for natural history lectures have been loaned extensively to persons engaged in educational or wild life protection and conservation work.

R. M. Anderson, zoologist (mammalia), Chief of the Biological Division, devoted considerable time to the administrative work and correspondence of the division and to the identification and study of the mammal collections. Many notes were added to the card catalogue records of bibliography and field notes on distribution and habits of the different species of Canadian mammals. Some time was devoted to editing and proofreading the scientific reports of the Canadian Arctic Expedition, 1913-18. He also represented the Department on the Advisory Board on Wild Life Protection.

Charles H. Young, senior collector-preparator, left Ottawa June 11 and did field collecting of mammals and birds at Youghall and on Miramichi Road Gloucester county, New Brunswick, until October 7. R. M. Anderson joined Mr. Young on the 26th of July at Youghall, soon afterwards moving to camp on the Miramichi Road and working there until October 7. This work had for its object an extension of the biological reconnaissance of the Maritime Provinces, and collection of museum material from regions not well represented in the national collections.

P. A. Taverner, ornithologist, left Ottawa May 14, 1921, and worked at Cypress Lake, Saskatchewan, until June 13, and around Eastend, Saskatchewan, until June 21. On June 27 he joined Mr. Hoyes Lloyd, supervisor of migratory birds protection, and together they worked through southern and west central Manitoba until August 29. The biological reconnaissance was continued in preparation of a proposed work on the "Birds of Western Canada", for the collection of museum material from new districts; and to assist in the investigation of the bird life in certain forest reserves and bird sanctuaries in the Prairie Provinces. Hamilton M. Laing, temporary assistant to Mr. Taverner, worked with him at Cypress Lake and Eastend, Saskatchewan, proceeding to Oak Lake, Manitoba, and remaining at Oak Lake until the end of October.

C. L. Patch, chief taxidermist and herpetologist; D. Blakely, taxidermist; and Claude E. Johnson, artist, continued the mounting of individual specimens and group preparations; old specimens have been cleaned and remade, and large skins tanned by J. E. Perron. Jos. Rochon and D. MacDonald have been engaged in cleaning and mounting osteological material. Some local field work has been done around Ottawa, collecting local material and accessories for habitat groups in the Museum.

The mammal accessions to the Museum during the year numbered 565, and bird accessions 1,300 specimens.

Work in the botanical section was handicapped early in the year on account of no botanist being regularly at work since the death of James M. Macoun in 1920: although Mr. M. O. Malte, Dominion agrostologist, of the Department of Agriculture, had been appointed honorary curator of the National Herbarium and had put in as much time as could be spared from his duties at the Experimental Farm. Mr. Malte was later appointed Chief Botanist, National Herbarium, and took over the duties of the position November 1, 1921. He has resumed the exchange of duplicate herbarium sheets which was interrupted by the death of Mr. Macoun, card catalogued the books and pamphlet publications, and done considerable work in editing and proofreading several important botanical publications. He also took up the final work on the "Flora of the Ottawa Region," the material and manuscript of which had been accumulating for years under the hands of the late Professor John Macoun and James M. Macoun and it is hoped that the work will be brought into shape for printing during the ensuing year.

The most important botanical publications issued during the year were:

"A Botanical Exploration of the North Shore of the Gulf of St. Lawrence," by Harold St. John.
"Report of the Canadian Arctic Expedition, 1913-18, Vascular Plants," Volume V, Part A, by James M. Macoun and Theo. Holm.
Ibid. Volume V, Part B. "Contributions to the Morphology, Synonymy, and Geographical Distribution of Arctic Plants," by Theo. Holm.

Many botanists and botanical students have availed themselves of the herbarium for purposes of study and for the comparison of material, and many specimens have been sent in and determined. Although the division has neither the staff nor facilities for the determination of all common collections that may be submitted, it is glad to examine and compare specimens and discuss technical points with curators of local herbaria, colleges, experiment stations, and advanced collectors.

Plants received, outside of collections by staff:

	Sheets
New York Botanical Garden	1,195
Gray Herbarium, Cambridge	360
State University of New York, Albany	550
C. H. Morse, collected by W. D. Cram	127
George S. Hume	34
Miss H. Potter (from Yukon)	14
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	2,270
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MINES BRANCH

John McLeish, Director

FUNCTION AND ORGANIZATION

The general scope of the Mines Branch function to which particular attention has so far been given, has been the collecting of information and the conducting of investigations designed to promote the efficient development and utilization of the mineral resources. This is a broad field of activity, extending from the commercial development of mineral deposits to the production and utilization of the marketable products.

The plan of the work has been to collect statistics of mineral production (a duty recently transferred to the Dominion Bureau of Statistics); to study and collect information regarding the mining industry in all its phases, including extent of resources, methods of mining, processes of recovering marketable products, the nature and character, chemical and physical, of the ores and minerals, intermediate and final marketable products, the uses to which products are put, prices, markets, marketing conditions, and other related economic facts.

Chemical, testing, and experimental laboratories have been established to make studies and investigations respecting ore dressing and metallurgy; the fuels, coal, peat, petroleum, gas, and oil-shales; clays, ceramic materials, refractory materials, structural materials, and the various rocks, sand, and gravels used for road building; all with a view to determining the character of products, testing products and processes, determining the most suitable processes to employ to secure results desired—whether in the production or in the utilization of mine products, the prevention of waste, and the protection of life.

The work, while primarily investigative, has involved the installation of equipment that enables the Branch to furnish a great deal of assistance to other departments in the making of chemical and physical examinations and tests.

To the above investigative function is added the administration of the Dominion of Canada Assay Office at Vancouver, B.C.

The growth of the organization for carrying on the work of the Branch has not been so rapid as the importance of developing the natural resources of the country would seem to require. In fact, it has been very adversely affected during recent years by resignations from the technical staff, and the Branch has been quite unable to meet all the many demands made upon it for information and investigations.

It is proposed that the work be continued under the following organization:

Administrative:

Secretarial

Library

Draughting Division

Dominion of Canada Assay Office, Vancouver, B.C.

Investigative:

Mineral Resources Division

Ore Dressing and Metallurgical Division

Fuels and Fuel Testing Division

Ceramics and Road Materials Division

Chemical Laboratory Division

Under the Division of Mineral Resources will be included the investigation of mineral resources and their technology, production, uses, markets, marketing conditions, formerly undertaken in the Metal Mines, Non-Metalliferous Mines, and Mineral Resources and Statistics Divisions. There is a very great demand for this information.

The Ore Dressing and Metallurgical Division, Fuels and Fuel Testing Division, Ceramics and Road Materials Divisions, will be charged primarily with laboratory testing and research investigations on ores and minerals and on processes for their treatment and recovery; on mineral products, and on methods and purposes of their utilization.

There is great need of and opportunity for securing exceedingly valuable results from the study and investigation of mining and marketing conditions. The natural mineral resources of Canada require to be administered under laws and regulations that will best serve the public interest. Production should be made in a manner and under conditions that will give a maximum recovery of valuable constituents with a maximum protection of health and life, and of associated mineral resources not being immediately exploited. Such assistance as is properly within the function of Government to grant should be given, to facilitate the development of and supplying of markets both at home and abroad for those mineral resources that are susceptible of economic and profitable exploitation.

At the present time Canada, notwithstanding apparent enormous mineral resources, is a very large importer of certain mineral products, and although economic conditions play a very important part in this international trade in products of the mine, nevertheless, much of it is due to a lack of knowledge of our own resources and of the means to make them marketable. This applies with particular force to our great and varied resources in non-metallic products.

REVIEW OF ACTIVITIES

Investigations undertaken during the year, other than those of routine character, were mainly continuation of work in progress. Investigations of mineral resources and their technology were made with particular reference to iron, molybdenum, mineral pigments (ochres), alkali deposits (sodium and magnesium sulphates), soapstone and talc, and bituminous shales of Manitoba and Saskatchewan. These, and the laboratory tests made, are referred to in the following statements.

MINERAL RESOURCES AND TECHNOLOGY

CHEMICAL AND METALLURGICAL INDUSTRIES INVESTIGATION

A. W. G. Wilson, Chief of the Metal Mines Division, has been engaged at intervals throughout the year in the compilation of his "Report on the Development of Chemical and Metallurgical Industries in Canada." About one-half the time of this officer has been occupied in the preparation of memoranda and in replying to inquiries relating to chemical and metallurgical industries. A special report was prepared on the Malagash salt area. Mr. Wilson served, also, on several inter-departmental committees.

IRON ORES AND THE IRON INDUSTRY

A. H. A. Robinson spent the winter months in completing a report on the titaniferous iron ore resources of Canada. Two months were spent in the field, obtaining information on the iron industry of Canada.

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MOLYBDENUM

V. Eardley-Wilmot was engaged throughout the year in the preparation of a monograph on molybdenum.

MINERAL PIGMENTS

The investigation of the mineral pigment deposits of eastern Canada was continued by H. Frechette. The field work in 1921 was entirely in the province of Ontario; Quebec and the Maritime Provinces having been covered previously. Attention was confined to deposits lying within those parts of eastern Ontario served by easy transportation.

Almost all the ochre deposits seen are too small to be prospective producers, though some have, in the past, produced a limited amount of pigment. Most of the deposits have resulted from the oxidizing of chalybeate waters issuing from rock formation, whereas the larger ochre deposits of Quebec owe their origin to springs issuing from immense sand fields. In the county of Halton, certain clays have in the past been used for paint making. With an increased demand for low grade material they may again find a market as pigment for oilcloth manufacture or for some such purpose. Aside from these clays there is small promise of a mineral pigment industry in eastern Ontario.

SODIUM AND MAGNESIUM SULPHATE DEPOSITS

The investigation of the alkali deposits of western Canada was commenced by L. H. Cole. The field work in 1921 was confined mainly to Saskatchewan, with only preliminary examinations of a few of the larger deposits in Alberta. Attention was centred primarily on some of the larger typical deposits situated convenient to transportation, and on several smaller deposits which showed peculiarities varying somewhat from the general type.

Natural occurrences of soluble mineral salts are known in Manitoba, Saskatchewan, Alberta, and British Columbia, either in the form of bedded deposits, or as brines. Some of these deposits are probably of sufficient size to warrant commercial development, provided advantageous freight rates and a sufficient market can be obtained.

The salts in these deposits consist chiefly of mixtures of hydrous sodium and magnesium sulphates in varying proportions, with, generally, small quantities of sodium chloride and possibly other salts such as sodium carbonate, etc.

These deposits vary little in character although the percentage of the different salts varies in different localities. The deposits range from a few acres to many acres in extent, and in thickness from a few inches to 15 feet or more. The salts are generally found interbedded or mixed with calcareous mud or peaty material, and in very few instances are the deposits in a form pure enough to be sold in their raw state. The mud beds also contain numerous crystals of the alkali salts.

OIL-SHALES IN MANITOBA AND SASKATCHEWAN

S. C. Ells examined certain Cretaceous shales in Manitoba and Saskatchewan to determine their value as a possible source of crude petroleum. The results of this investigation were embodied in a bulletin (Memorandum Series, No. 3), issued in December, 1921.

BARIUM, STRONTIUM, TALC, AND SOAPSTONE

H. S. Spence continued his investigation of non-metallic minerals. During the year a report entitled "Barium and Strontium in Canada" was completed and sent to press. The field work consisted of the examination of deposits of talc and soap-

stone in Ontario and Quebec, in order to secure additional data for a report now being prepared. A number of deposits of non-metallic minerals in eastern Ontario were also examined.

MINERAL PRODUCTION RECORDS AND REPORTS

A. Buisson and J. M. Casey collected statistics of mineral production in Canada covering the calendar year 1920, and prepared for publication the "Annual Report on Mineral Production in Canada during the Calendar Year 1920," a preliminary report in respect to which had already been issued. In preparing this record for 1920, the Mines Branch was associated with the Dominion Bureau of Statistics which will in future attend to this work.

Mr. Buisson completed the more detailed report on the "Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals in Canada, 1920," and revised the lists of "Metal Mines" and "Metallurgical Works." Mr. Casey completed the detailed report on "Production of Coal and Coke in Canada," and revised and prepared for printing the various lists of non-metallic mines and quarry operators.

MINERAL RESOURCES INDEX INVENTORY

Mr. Buisson's activities have been mainly devoted to the development of the Mineral Resources Index Inventory referred to in previous years, and more completely described in the Report of the Munitions Resources Commission. The great value of such an Index Inventory has been demonstrated, by experience, but to build it up will require a larger technical staff.

ORE DRESSING AND METALLURGICAL DIVISION

W. B. Timm, Chief of the Division, reports very satisfactory progress has been made, considering the limited staff of technologists employed. The technical staff, depleted during 1919 by resignations, was augmented by the temporary appointment of C. S. Parsons as Engineer, Grade II, on February 1, 1921. On August 1, 1921, he received permanent appointment. On July 11, 1921, B. P. Coyne was appointed temporarily to the position of Assistant Chemist.

The work of the division has been centred, mainly, on methods of treating Canadian ores. For this purpose well-equipped experimental and chemical laboratories are maintained for testing on both a laboratory and a commercial scale.

Mr. Timm visited the Eastern Townships, Quebec, in connexion with the milling of asbestos rock.

INVESTIGATIONS CONDUCTED DURING 1921

Shipments of gold ores from Rice Lake district, and from Herb Lake district, were received. The test work on these ores, which contain metallic sulphides such as chalcopyrite, arsenopyrite, pyrite, sphalerite, and galena, was conducted by R. K. Carnochan.

An investigation was made by R. K. Carnochan on the milling of two types of asbestos rock from East Broughton and Black Lake, Que.; and on the concentration of garnet from Ontario.

C. S. Parsons, assisted by R. J. Traill, conducted an investigation on the concentration of the lead carbonate and zinc-lead sulphide ores of Kimberley, B.C.; and with R. K. Carnochan made a series of comparative tests on the concentration of the low-grade copper ores of Hidden creek, Anyox, B.C.

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Investigations were carried on by Mr. Parsons (assisted by R. J. Traill) on the concentration of the Flin-Flon sulphide ore, and a further investigation is being made on the disseminated ore from the same ore-body; (assisted by B. P. Coyne) on the treatment of the complex zinc ores of the Stirling mine, Cape Breton, N.S., and on the concentration by tabling and flotation of the lower-grade copper-nickel ores of the Sudbury district. H. C. Mabee is conducting the work in connexion with the precious metal values in these ores.

Mr. Parsons also completed an investigation on the recovery of brass from foundry refuse.

An investigation is being conducted to stimulate the use by operating companies of oils and other flotation re-agents manufactured, or which could be manufactured, in Canada, if markets were available.

R. K. Carnochan investigated the concentration of the radioactive mineral euxenite, and is working on the recovery of the values in a gold ore from Arrowhead, B.C.

Mr. Parsons also investigated the concentration of several shipments of molybdenite and graphite ores.

H. C. Mabee worked on the recovery of the metals of the platinum group from placer concentrates of the Cariboo district, B.C., and is working on the precious metal values in the pyrrhotite ores of Canada.

ADDITIONAL EQUIPMENT

During the year the following was added to the equipment of the laboratories:

A Standard Asbestos Testing Machine.

A Dorr Simplex Classifier, with bowl attachment, specially built so it can be operated as a simplex classifier, or as a bowl classifier.

A Davis Magnetic Log Washer.

A Four-unit Muffle Furnace.

The portion of the chemical laboratories destroyed by fire in the previous year was rebuilt. The chemical work which had been carried on at the Mines Branch laboratories, Sussex street, was transferred back to the laboratories of the division in February.

FUELS AND FUEL TESTING DIVISION

B. F. Haanel, Chief of the Division, reports that the division was still handicapped by depletions in the staff, which took place during the year 1920-21. Three of the vacancies in the chemical staff were filled early in the year, but the positions of Chief Engineering Chemist and Technical Engineer, were still vacant at the close of the fiscal year.

INVESTIGATIONS PLANNED

The appropriations for 1921-22 provided for the completion of the investigation of Canadian oil-shales and peat for the recovery of oil; and the carbonization of Canadian lignites and peat. An investigation in regard to the efficient burning of Canadian fuels has been commenced, but is proceeding slowly owing to the limited staff available. It is important that this investigation be proceeded with vigorously, so that Canadian fuels may be used instead of imported fuels.

Funds at the disposal of the division for collecting information regarding the use of fuels for power and heating purposes can be satisfactorily employed only when the present vacancies are filled and additional technical staff secured.

INVESTIGATIONS AND EXAMINATIONS MADE BY THE CHIEF OF THE DIVISION

B. F. Haanel, in addition to his regular duties, visited laboratories in the United States where investigations were being conducted on the distillation of oil-shales and coal. He superintended a test with the Ryan Process on a sample of oil-shale obtained from Albert Mines, N.B. He interviewed several chemists and engineers who had processes for recovering oil from shale, and he made trips to Petrolia and Edmonton to examine processes for extracting bitumen from the tar sands of Alberta. In September he attended the meeting of the Canadian Mining Institute at Edmonton and on his return journey to Ottawa visited the briquetting plant erected by the Lignite Utilization Board at Bienfait. He also conducted all the secretarial work of the Peat Committee.

E. S. Malloch has performed the duties of Technical Engineer since the resignation of John Blizard. In addition to his routine work he has prepared for publication John Blizard's report on the "Preparation, Transportation, and Combustion of Powdered Coal," and the report entitled "Gas Producer Trials with Alberta Coals," by John Blizard and E. S. Malloch. He conducted a series of tests on a small domestic hot-water heater designed for burning lignite coal, and is investigating the combustion of fuels in a standard domestic hot-water boiler.

CHEMICAL LABORATORIES

J. H. H. Nicolls, Acting Chief Engineering Chemist, reports that over two hundred samples of fuels were analysed for the various departments of the Government and for private individuals. Further progress was made with the laboratory scale investigations on carbonization of lignite and peat by H. Kohl and others, and the work on oil-shale has been proceeding satisfactorily.

SPECIAL INVESTIGATIONS

Work has been begun on the investigation of the briquetting of peat when mixed with a bituminous slack and anthracite dust. P. V. Rosewarne carried out an investigation concerning the lubricating qualities of cod liver oil as compared with those of castor oil.

NEW EQUIPMENT

B. F. Haanel obtained, free of charge, an equipment for burning powdered coal, which will be installed early in April, 1922.

CERAMIC DIVISION

The work of the Ceramic Division for the past season consisted as usual in the investigation of the raw materials used in the ceramic industries.

The field work consisted in gathering data for a bulletin on the clay and shale deposits of Ontario, and a visit to the Grand Lake coal area in New Brunswick to sample clays in the coal mines.

A large number of samples of clays and shales were tested for pebbles in various parts of the Dominion, and an important series of successful tests were run to determine the cause of, and to correct a bad case of, scumming submitted for investigation by one of the large brick manufacturing plants.

On October 1, 1921, Mr. Keele accepted transfer to the classification of geologist and during the last half of the fiscal year Howells Frechette has been acting as Chief of the Ceramic and Road Materials Division, and conducting or supervising the laboratory work.

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ROAD MATERIALS DIVISION

The work on road materials, carried on by Henri Gauthier, in charge, and R. H. Picher, included the examining and sampling of a number of gravel deposits and rock quarries along the Ottawa-Pointe Fortune highway in Ontario, and the continuation of a road material survey in Rocky Mountains park, B.C., in connexion with the construction of automobile roads by the Parks Branch of the Department of the Interior.

The first of these investigations, undertaken at the request of the Ontario Highways Department, was limited to the examination of certain deposits selected by the Resident Engineer in charge of the highway, about a week's time only being available for the field study. In the Rocky Mountains Park investigation, materials along the entire Banff-Lake Louise road, a distance of 35 miles, and along approximately 50 miles of the Castle-Windermere road, were examined. There still remain about 25 miles of this road to be surveyed for road materials. With this work accomplished, complete information regarding the available road materials for these two highways will be at the disposal of the engineers and contractors in charge of their surfacing and maintenance.

The carrying on of the field work of these investigations was very greatly facilitated by assistance received from Messrs. R. S. Stronach, Superintendent, Rocky Mountains park, and J. M. Wardle, Chief Highway Engineer, and their assistants.

A special memorandum was prepared by Mr. Gauthier for the information of Mr. A. W. Campbell, Federal Commissioner of Highways, dealing with the comparative value of the various classes of road-building rock as surfacing material.

A number of samples of road stone and gravel, other than those collected by the officers of the division, were tested and reported upon.

An experimental abrasion test on concrete cylinders was undertaken, at the request of the Department of Public Works, Ottawa, to secure information on the comparative resistance to wear of concrete mixtures.

CHEMISTRY DIVISION

The work of the Chemical Division, under the direction of F. G. Wait, Chief of the Division, has been carried on along two lines—special investigations, and regular routine—in the course of which 754 samples have been dealt with.

H. A. Leverin has performed a large number of analyses of a routine character. During the summer months, his services were loaned to the Peat Committee and his whole time given to that work.

R. T. Elworthy has been engaged in an investigation of the possibility of oxidation of natural gas; and of problems submitted by the Air Board—including a study of dressings for aeroplane fabric, and of glues—as well as performing analyses of waters encountered in the deep borings for oil and gas in Saskatchewan and Alberta.

E. A. Thompson, assisted by A. Sadler, has been engaged in an investigation of the colloidal clay—bentonite. Mr. Sadler has, in addition, made several partial analyses and assays.

James Moran has been in charge of the analyses of mine air samples.

DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C.

George Middleton, manager of the office, reports the receipt of deposits during the calendar year ended December 31, 1921, as follows:

There has been an increase in the number and value of gold bullion deposits as compared with the previous year, the figures being 1,460 deposits of a total value

of \$2,831,499.61 during the year just ended, as against 1,346 deposits of a total value of \$2,499,174.41 during the year 1920.

A total of 1,514 meltings and 1,514 assays (in quadruplicate) was required in connexion with the purchase and disposal of the bullion, including the melting into large bars of the smaller deposits after purchase, and the assaying of same prior to shipment to the Royal Mint, Ottawa.

The aggregate weight of the gold bullion deposits before melting was 163,070.56 troy ounces and after melting 160,826.37 troy ounces, showing a loss in melting of 1.3762 per cent. The loss in weight by assaying was 22.89 troy ounces, making the weight of bullion after melting and assaying 160,803.48 troy ounces, the average fineness of same being 850.5 parts per thousand gold and 121 silver.

The net value of the gold and silver contained in deposits was \$2,834,499.61, received from the undermentioned sources:

Source	Number of deposits	Weight		Net value
		Before melting and assaying	After melting and assaying	
		(troy ozs.)	(troy ozs.)	\$ cts.
British Columbia.....	958	80,772.93	79,336.15	1,492,970 45
Yukon Territory.....	495	82,219.92	81,393.04	1,340,224 97
Alberta.....	2	19.96	19.04	345 14
Alaska.....	5	57.75	55.25	959 05
	1,460	163,070.56	160,803.48	2,834,499 61

DRAUGHTING DIVISION

H. E. Baine, Chief Draughtsman, reports:

Fifteen maps have been compiled and drawn for photolithography, and are now ready for publication. They are listed below without publication numbers. Four maps are now in preparation; none is at present in the hands of the King's Printer.

About eight hundred index maps were prepared for the Division of Mineral Resources and Statistics.

One hundred and forty drawings, charts, flow-sheets, etc., were made for the illustration of various reports.

About four hundred negatives and black and white prints were made from the photostat machine, and about two hundred and fifty prints were made from the blue print machine.

Four hundred half-tone blocks and zinc cuts were sent out, received, and filed during the year.

Maps Ready for Publication

Structural materials along the St. Lawrence river, between Prescott, Ont., and Lachine, Que., in three sheets; scale, 1 mile to 1 inch.

- Morrisburg sheet.
- Cornwall sheet.
- Valleyfield sheet.

Bituminous sands, northern Alberta:

Index map showing provisional classification of principal outcrops of bituminous sand in northern Alberta.

- Hangingsstone-Horse River sheet
- Clearwater River sheet
- Christina River sheet
- Steepbank River sheet
- Moose River sheet
- McKay River sheet

Drawn on a scale of 1,000 feet to 1 inch.
To be published on a scale of 2,000 feet to 1 inch.

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- Map showing provisional classification of principal outcrops of bituminous sand in northern Alberta (4 sheets); scale, 40 chains to 1 inch.
- Map showing provisional classification of principal outcrops of bituminous sand in northern Alberta; scale, 5 miles to 1 inch.
- Sketch map of Lake Ainslie district, Cape Breton, Nova Scotia, showing location of barytes deposits; scale, 16 miles to 1 inch.
- Map showing position of outcrops of Cretaceous shales, sampled during the year 1921, in Manitoba and Saskatchewan; scale, 35 miles to 1 inch.
- Map showing position of outcrops of Cretaceous shales, sampled during year 1921, in Pasquia Forest reserve, Saskatchewan; scale, 35 miles to 1 inch.

In Preparation

- Map showing road materials available for highway construction in Soulanges and Vaudreuil counties, Quebec; scale, 2 miles to 1 inch.
- Map showing road materials available for highway construction between Prescott and Gananoque, Ontario; scale, 2 miles to 1 inch.
- Map showing road materials available for highway construction between Gananoque and Napanee, Ontario; scale, 2 miles to 1 inch.
- Map showing road materials available for highway construction between Napanee and Port Hope, Ontario; scale, 2 miles to 1 inch.

LIBRARY

Mrs. O. P. R. Ogilvie, Librarian, reports that the Mines Branch Library has grown very appreciably during 1921. New filing cabinets have been added to accommodate the expansion of the card catalogue.

An original extension of the Dewey Classification System has been completed which, in application, has proved most valuable to the specific requirements of this library.

ACCESSIONS, 1921

Books (by gift)	9
Books (by purchase)	244
Books (bound)	107
Canadian government documents	538
Foreign government documents	1,159
Scientific societies, bulletins, proceedings, and transactions	511
Pamphlets	217
Trades catalogues	143
Maps	87
Total accessions	<u>3,015</u>

EXPLOSIVES DIVISION

Lt.-Col. G. Ogilvie, Chief Inspector of Explosives

Satisfactory progress has been made in this the second year of operation of the Explosives Act, in the promotion of an understanding of its provisions as affecting all who have occasion to store or use explosives, and in the enforcement of the observance of the regulations made under the Act.

Four new factories have been established and licensed, and two others have ceased operation, bringing the total of licensed factories in Canada at the end of the financial year to nineteen. Many improvements have been effected in the factories previously established, to facilitate their operation in accordance with the regulations. In one case the licence for a factory was suspended pending reorganization, this action arising from the failure of the management to conduct the work of the factory in compliance with the regulations.

There are in effect ninety-one licences or continuing certificates covering the use of permanent magazines, and one hundred and three licences for temporary magazines. The issue of these licences, which apply to magazines previously in operation, has in most cases been conditional on the carrying out of certain specified improvements in construction, or on limitation of the quantity and nature of explosives to be stored, as have been deemed necessary in the interest of the public safety.

The investigations which have been made into the conditions of storage have, in several cases, resulted in the condemnation of the magazine in use, and either a new magazine built, or proper disposal otherwise made of the explosives.

In the inspection of these magazines valuable assistance has been given by the Royal Canadian Mounted Police between whom and this staff close co-operation has been maintained. The regulation of the storage of explosives in small quantities in premises which do not require to be licensed has been made possible by the activities of that force whose members have visited approximately 1,600 such places, generally twice, in the course of the year.

Special consideration has been given to the special circumstances attending the keeping of explosives by persons engaged in certain industries, as in logging or farming, and steps taken to explain the requirements of the regulations to them. The purpose of the Act in this respect has been well understood and appreciated, and with the co-operation of the companies, farmers institutes, and other bodies concerned, it has been possible to satisfactorily regulate such storage in accordance with the Act, while causing the minimum inconvenience or expense to the operators.

With regard to the application of the Act in relation to the storage of explosives in general, it is to be observed that the improvement in the conditions of storage which has been, and is being, effected is not confined to that which could reasonably be expected as a result only of the application of regulations enforced by visits of inspection. The attention so called to the importance of the observance of good practice in the interests of the safety of employees and the public has, with comparatively few exceptions, resulted in owners exercising a closer supervision on such matters than was formerly common.

As was to be expected, greater difficulty has been experienced in obtaining satisfactory results in the regulation of storage of explosives by construction parties than in the case of those persons who have permanent locations. This is being over-

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come as contractors become known, and with the assistance rendered by several public bodies in giving advice of contracts placed, and by the Royal Canadian Mounted Police in locating work parties.

Prosecutions were made in twelve cases, during the financial year, for violation of the regulations and convictions obtained in all cases.

The greater number of importation permits issued were in respect to fireworks. The difficulty in obtaining adequate declarations of Chinese fireworks, which necessitated the exclusion of all save certain defined small natures, has been largely overcome by the assistance rendered by Customs Brokers, and it has been possible to authorize a considerable variety of these fireworks while ensuring the non-admittance of those of an undesirable character.

It has been found necessary, by reason of their unsuitable composition, to exclude certain of the retail fireworks formerly supplied by manufacturers in the United States.

Ninety-six accidents with explosives were traced in 1921. These involved the death of twenty-three persons and injury to ninety others. The circumstances and causes of these, as far as can be determined, are summarized in the Annual Report of the Explosives Division. It is noteworthy that these include no fewer than twenty-one, whereby two persons were killed and thirty injured, which were brought about by persons playing with explosives which, if properly kept, should in the great majority of the cases, never have fallen into the hands of the persons, generally children, who obtained them.

The staff of the division was increased by the appointment of Lt.-Colonel F. E. Leach as Inspector of Explosives on July 28. Lt.-Colonel Leach has since been employed in western Canada. Mr. M. C. Fletcher was appointed to the position of chemist on December 1, 1921.

EDITORIAL DIVISION

William McInnes, Editor-in-Chief

The Department issues from time to time, as they can be prepared, reports, memoirs, and bulletins from its various divisions. Memoirs and bulletins of the Geological Survey and Victoria Memorial Museum are issued under the supervision of F. Nicolas, Editor: reports of the Mines Branch, under the supervision of Samuel Groves, Editor. In addition to the reports issued in English, many are issued in French, under the supervision of C. E. Rivier and E. P. Lévesque, Mr. Paradis, Head Translator, being absent through illness.

The following lists include the reports published by the Department from January 1, 1921, to March 31, 1922; and the French publications distributed during that period.

DEPARTMENT OF MINES

English Publications

1903. *Report of the Department of Mines for the Fiscal Year Ending March 31, 1921*; 47 pages; 4,000 copies; published, November 30, 1921.

GEOLOGICAL SURVEY

English Publications

1713. Memoir 108. Geological Series 92, *The Mackenzie River Basin* (revised edition)—by Charles Camsell and Wyatt Malcolm; 151 pages, 14 plates, 1 figure, 1 map; 4,000 copies; published April 26, 1921.
1819. Memoir 118. Geological Series 100, *Mineral Deposits Between Lillooet and Prince George, B.C.*—by Leopold Reinecke; 129 pages, 17 plates, 18 figures; 2,500 copies; published January 6, 1921.
1820. *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1919, Part E*; 48 pages, 10 figures, 7 maps; 3,000 copies; published February 2, 1921.
1821. Memoir 119. Geological Series 101, *The Reed-Wekusko Map-area, Northern Alberta*—by F. J. Alcock; 47 pages, 6 plates, 2 maps; 3,000 copies; published January 18, 1921.
1824. Memoir 120. Geological Series 102, *The Hadrosaur Edmontosaurus from the Upper Cretaceous of Alberta*—by Lawrence M. Lambe; 79 pages, 39 figures; 3,500 copies; published January 5, 1921.
1825. *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1919, Part F*; 25 pages, 4 maps; 3,000 copies; published January 28, 1921.
1832. Museum Bulletin No. 31. Geological Series 38, *A Contribution to the Description of the Fauna of the Trenton Group*—by P. E. Raymond; 64 pages, 11 plates; 2,000 copies; published February 23, 1921.
1834. Memoir 122. Geological Series 104, *Sheep River Gas and Oil Field, Alberta*—by S. E. Slipper; 46 pages, 8 plates, 4 figures, 3 maps; 2,500 copies; published April 8, 1921.
1837. Memoir 123. Geological Series 105, *Sixty-mile and Ladue Rivers Area, Yukon*—by W. E. Cockfield; 60 pages, 6 plates, 1 map; 2,750 copies; published March 4, 1921.
1840. Bulletin No. 32. Geological Series 39, *Inyoite from New Brunswick*—by Eugène Poitevin and H. V. Ellsworth; 21 pages, 3 plates, 10 figures; 1,800 copies; published May 21, 1921.
1862. *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1919, Part A*; 19 pages; 3,000 copies; published May 4, 1921.
1863. Memoir 124. Geological Series 106, *Northeastern Part of Labrador, and New Quebec*—by A. P. Coleman; 68 pages, 10 plates, 3 maps; 2,500 copies; published July 20, 1921.

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1864. Bulletin No. 33. Geological Series 40, *Faunal and Sediment Variation in the Anticosti Sequence*—by W. H. Twenhofel; *New Species of Devonian Crinoidea from Northern Canada*—by Frank Springer; *The Range of Certain Lower Ordovician Faunas of the Ottawa Valley with Descriptions of Some New Species*—by Alice E. Wilson; *The Fossil Molluscan Faunas of the Marl Deposits of the Ottawa District*—by E. J. Whitaker; *Two New North American Cycadeoids*—by G. R. Wieland; 109 pages, 12 plates, 8 figures; 2,250 copies; published October 13, 1921.
1866. Memoir 129. Geological Series 110, *Geology of the Moncton Map-area*—by W. J. Wright; 69 pages, 7 plates, 3 figures, 4 maps; 2,500 copies; published March 2, 1922.
1867. *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1920, Part C*; 32 pages, 5 figures, 4 maps; 4,000 copies; published July 15, 1921.
1868. Memoir 125. Geological Series 107, *Sedimentation of the Fraser River Delta*—by W. A. Johnston; 46 pages, 4 maps, 5 diagrams; 2,500 copies; published September 10, 1921.
1869. *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1920, Part A*; 106 pages, 8 figures, 10 maps; 4,000 copies; published, July 27, 1921.
1870. *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1920, Part E*; 20 pages; 3,000 copies; published June 24, 1921.
1874. *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1920, Part B*; 67 pages, 5 plates, 10 figures, 2 maps; 5,000 copies; published June 8, 1921.
1881. *Summary Report of the Geological Survey, Department of Mines, for the Calendar Year 1920, Part D*; 87 pages, 14 figures, 1 map; 3,500 copies; published September 30, 1921.
1883. *Economic Minerals of Canada*. Pamphlet on—by Wyatt Malcolm, for distribution to the Seventh National Exhibition of Chemical Industry, New York; 34 pages, 1 plate; 10,000 copies; published September 6, 1921.
1900. Memoir 127. Geological Series 108, *Beauceville Map-area, Quebec*—by B. R. MacKay; 105 pages, 13 plates, 7 figures, 2 maps; 2,500 copies; published December 31, 1921.
1904. Memoir 128. Geological Series 109, *Winnipegosis and Upper Whitemouth River Areas, Manitoba; Pleistocene and Recent Deposits*—by W. A. Johnston; 42 pages, 2 figures, 2 maps; 2,500 copies; published, December 23, 1921.

Report of the Canadian Arctic Expedition, 1913-1918—

- Volume III: *Insects, Part K, Insect Life on the Western Arctic Coast of America*—by Frits Johansen; 61 pages, 10 plates, 1 figure; 3,000 copies; published November 7, 1921.
- Volume IV: *Botany, Part E, Mosses*—by R. S. Williams; 15 pages, 1 plate; 3,500 copies; published February 8, 1921.
- Volume V: *Botany, Part A, Vascular Plants*—by James M. Macoun and Theo. Holm; 51 pages, 13 plates; 3,500 copies; published October 14, 1921.
- Volume V: *Botany, Part B, Contributions to the Morphology, Synonymy, and Geographical Distribution of Arctic Plants*—by Theo. Holm; 139 pages, 6 plates, 18 figures; 3,500 copies; published February 10, 1921.
- Drillers' Notebook for the Borings Division, Geological Survey*; published August 31, 1921.
- A Supplementary Study of Panoplosaurus Mirus* (Royal Society paper)—by C. M. Sternberg; reprints from the University of Toronto Press, 250 copies; published March 28, 1922.

French Translations

1564. Mémoire 104, n° 3 série biologique. *Les oiseaux de l'est du Canada*—by P. A. Taverner; 307 pages, 50 coloured plates, 68 figures; 1,500 copies; published January 6, 1921.
1818. Mémoire 109, n° 94 série géologique, *Le bassin des rivières Harricana et Turgeon dans le nord du Québec*—by T. L. Tanton; 92 pages, 9 plates, 2 figures, 1 map; 1,000 copies; published January 7, 1921.
1871. *Rapport sommaire de la Commission géologique du Ministère des Mines, pour l'année civile 1919, Partie A*; 19 pages; 800 copies; published July 27, 1921.

MINES BRANCH

English Publications

337. *Catalogue of Mines Branch Publications, 11th edition*; 35 pages, 2,000 copies; published September 15, 1921.
- Price list of Mines Branch Publications*; 7 pages; 500 copies; published October 28, 1921.
396. *Phosphate in Canada*. Report on—by Hugh S. Spence; 156 pages, 32 plates, 12 figures, 13 maps; 5,000 copies; published February 11, 1921.

¹ These reports were published under the supervision of R. M. Anderson, Chief, Biological Division.

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542. *Summary Report of the Mines Branch, Department of Mines, for the Calendar Year 1919*; 182 pages, 2 figures, 5 diagrams; 2,500 copies; published January 17, 1921.
545. *The Mineral Production of Canada, for the Calendar Year 1919*. Annual report on—by John McLeish; 82 pages, 4,000 copies; published February 21, 1921.
547. *Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals in Canada during the Calendar Year 1919*. Report on—by John McLeish; 76 pages, 3,000 copies; published April 11, 1921.
548. *Production of Coal and Coke in Canada During the Calendar Year 1919*. Report on—by John McLeish; 39 pages; 3,000 copies; published April 1, 1921.
554. *The Mineral Production of Canada for the Calendar Year 1920*. Preliminary report on—by John McLeish; 24 pages; 6,000 copies; published March 1, 1921.
564. *The Preparation, Transportation, and Combustion of Powdered Coal*—by John Blizard; 131 pages, 3 plates, 39 figures; 4,000 copies; published November 3, 1921.
565. *Gas Producer Trials with Alberta Coals*. Bulletin No. 33—by John Blizard and E. S. Malloch; 40 pages, 1 figure, 18 charts; 4,000 copies; published November 24, 1921.
566. *Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and Other Metals in Canada During the Calendar Year 1920*. Report on—by John McLeish; 76 pages; 3,000 copies; published December 17, 1921.
567. *Production of Coal and Coke in Canada During the Calendar Year 1920*. Report on—by John McLeish; 36 pages; 3,000 copies; published December 17, 1921.
568. *The Mineral Production of Canada During the Calendar Year 1920*. Annual report on—by John McLeish; 80 pages; 4,500 copies; published January 14, 1922.
574. *Summary Report of Investigations Made by the Mines Branch, Department of Mines, During the Calendar Year Ending December 31, 1920*; 87 pages, 8 figures; 3,000 copies; published March 6, 1922.

Note.—The following parts of the Summary Report were issued separately:

575. *Mineral Resources and Technology*; 22 pages, 1 figure; 1,000 copies; published March 31, 1922.
576. *Ore Dressing and Metallurgy*; 15 pages; 500 copies; published March 31, 1922.
577. *Fuels and Fuel Testing*; 30 pages; 1,000 copies; published March 31, 1922.
578. *Ceramics and Road Materials*; 20 pages; 1,500 copies; published March 31, 1922.

Lists of Mine Operators—

- List of metal mines in Canada; published October 31, 1921.
- List of petroleum and natural gas wells; published January 17, 1922.
- List of lime kilns in Canada; published December 14, 1921.
- List of cement mills and sand lime brick plants in Canada; published December 21, 1921.
- List of manufacturers of clay products in Canada; published January 15, 1922.
- List of metallurgical works in Canada; published July 27, 1921.
- List of coal mines in Canada; published December 29, 1921.
- List of stone quarry operators in Canada; published February 15, 1922.
- List of sand and gravel operators in Canada; published February 15, 1922.
- List of non-metal mines in Canada; published January 25, 1922.
- Statistical form 19C—silver, cobalt; published January 10, 1921.

French Translations

397. *Le phosphate au Canada*. Report on—by Hugh S. Spence; 169 pages, 32 plates, 12 figures, 13 maps; 1,000 copies; published February 16, 1922.
512. *Le graphite*. Report on—by Hugh S. Spence; 212 pages, 56 plates, 43 figures, 6 maps; 1,000 copies; published October 10, 1921.
543. *Rapport sommaire de la Division des Mines, du Ministère des Mines, pour l'année civile 1919*; 194 pages, 2 figures, 5 diagrams; 800 copies; published September 15, 1921.
546. *La production minérale du Canada pour l'année civile 1919*. Annual report on—by John McLeish; 82 pages; 800 copies; published August 5, 1921.

EXPLOSIVES DIVISION

English Publications

3. *Annual Report of the Explosives Division, Department of Mines, for the calendar year 1920*; 19 pages; 3,000 copies; published July 28, 1921.
5. *Annual Report of the Explosives Division, Department of Mines, for the calendar year 1921*; 18 pages; 2,500 copies; published March 22, 1922.

French Translation

4. *Rapport annuel de la Division des Explosifs, du Ministère des Mines, pour l'année civile 1920*; 19 pages, 1,000 copies; published November 22, 1921.

REPORTS IN PROGRESS ON MARCH 31, 1922

At the end of the fiscal year 1921-1922 the Geological Survey had, in the hands of the King's Printer, nine English reports and one French translation; the Mines Branch, two English reports and one French translation; and the Explosives Division, one French translation.

FRENCH PUBLICATIONS DISTRIBUTED FROM JANUARY 1, 1921, TO MARCH 31, 1922

The French publications of the Department of Mines, including those of the Geological Survey, the Mines Branch, and the Explosives Division, are distributed by the Editorial Division of the Department. From January 1, 1921, to March 31, 1922, there were distributed 12,141 copies in Canada and in foreign countries. Of these, 6,736 copies were forwarded in compliance with written or personal requests, and 5,405 copies were sent to addresses on the mailing lists.

	To applicants	To libraries, etc., on mailing lists	Total
Geological Survey.....	5,585	2,163	7,748
Mines Branch.....	1,139	2,683	3,822
Explosives Division ¹	12	559	571

¹Does not include copies distributed by the Explosives Division to their correspondents.

ACCOUNTING DIVISION

ACCOUNTANT'S STATEMENT

P. R. Marshall

The funds available for the work and expenditure of the Department of Mines for the fiscal year ending March 31, 1922, were:

	Grant	Expenditure	
		Amount	Total
	\$ cts	\$ cts	\$ cts
DEPARTMENT—			
Amounts voted by Parliament	234,078 14		
Civil list salaries.....		52,253 39	
Cost of living bonus.....		4,315 50	
Lignite Utilization Board.....		105,000 00	
Grant to Imperial Mineral Resources Bureau.....		12,166 67	
Grant to Canadian Institute of Mining and Metallurgy..		3,000 00	
Expenses of Explosives Division.....		10,299 39	
Civil Government contingencies.....		5,099 81	
			192,134 76
Balance unexpended and lapsed...			41,943 38
MINES BRANCH—			
Amounts voted by Parliament.....	434,843 04		
Civil list salaries.....		118,132 01	
Peat fuel investigations.....		40,122 05	
Expenses of fuel testing plant and laboratory.....		31,625 86	
Expenses of ore dressing and metallurgical laboratory..		23,001 53	
Investigations of ore deposits and economic minerals..		22,837 61	
Publication of reports and maps.....		15,882 26	
Wages of temporary employees.....		13,500 92	
Cost of living bonus.....		13,140 97	
Sundry printing and stationery.....		6,202 27	
Chemical laboratory		4,912 94	
Miscellaneous.....		2,987 88	
Advances 1921-22 to be accounted for in 1922-23, E. V. Moore \$100.....		100 00	
			222,446 30
Balance unexpended and lapsed...			142,396 74
DOMINION OF CANADA ASSAY OFFICE			
Amounts voted by Parliament.....	28,684 44		
Earnings.....	4,281 98		
Salaries of staff.....		19,280 00	
Cost of living bonus.....		2,044 44	
Fuel, power, and light.....		941 45	
Assayer's supplies.....		1,127 87	
Contingencies.....		693 08	
Premium on bonds.....		600 00	
Electric burglar alarm service.....		360 00	
			25,046 84
Balance unexpended and lapsed...			7,919 58
GEOLOGICAL SURVEY—			
Amounts voted by Parliament.....	667,180 91		
Civil list salaries.....		241,495 38	
Explorations, surveys, and investigations.....		180,251 07	
Publications of reports and maps.....		58,522 90	
Wages of temporary employees.....		37,630 24	
Cost of living bonus.....		23,908 33	
Sundry printing and stationery.....		20,096 22	
Miscellaneous.....		8,670 05	
Biological Division.....		3,677 58	
Forward.....	1,369,068 51	574,251 77	701,887 60

ACCOUNTANT'S STATEMENT—Continued

	Grant	Expenditure	
		Amount	Total
	\$ cts.	\$ cts.	\$ cts.
Forward	1,369,068 51	574,251 77	701,887 60
GEOLOGICAL SURVEY—Continued			
Photographic supplies		3,377 24	
Laboratory		2,894 98	
Specimens for Museum		2,376 63	
National Chemical Exposition.....		2,179 02	
School collections		1,885 00	
Instruments and repairs		831 12	
Expenditure chargeable to Superannuation Fund No. 4			
Retirement Act		150 00	
Advances 1921-22 to be accounted for in 1922-23, F. W.			
Waugh		1,900 00	
			589,845 76
Balance unexpended and lapsed.....			77,335 15
	1,369,068 51		1,369,068 51

Summary

	Grant	Expenditure	Grant not used
	\$ cts.	\$ cts.	\$ cts.
Civil Government salaries	477,250 00	383,447 82	93,802 18
Department	172,666 67	135,565 87	37,100 80
Mines Branch.....	272,100 00	158,519 85	113,580 15
Assay Office, \$26,000; earnings, \$4,281.98.....	30,281 98	22,362 40	7,919 58
Geological Survey.....	335,500 00	318,307 86	17,192 14
Cost of living bonus.....	43,403 24	43,403 24	
Increases due to reclassification	37,710 62	37,710 62	
Expenditure chargeable to Superannuation Fund No. 4,			
Retirement Act.....	150 00	150 00	
	1,369,068 51	1,099,473 66	269,594 85

Casual Revenue

Sales of explosives permits and licences.....	\$ 1,099 50
Sales of school collections and equipment.....	999 14
Sales of publications.....	723 48
Refunds, adjustment of cost of living bonus.....	820 04
Adjustment of claims for equipment lost.....	282 40
Revenue from fines for violations of the Explosives Act.....	180 00
	<u>\$ 4,104 56</u>

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